NELSON'S SCHOOL SERIES.

THE

SCIENTIFIC AND TECHNICAL READER.

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Preface.

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THOUGH not professing to be a Manual of the Sciences —a thing impossible within the limits of a single volume—this Work is yet so arranged as to present the leading features of a connected compendium. The object of the Compiler has been at once to instruct and attract;—to instruct by facts drawn from the most direct and authentic sources; and to attract by presenting these facts in the most intelligible language at command. There is nothing given in these pages beyond the comprehension of an advanced pupil of average ability; and where technicalities appear they are explained as they occur, that there may be no interruption to the sequence, nor imperfect understanding of the information intended to be conveyed. In this respect, indeed, the volume may be regarded as fitted alike for the general reader and the schoolboy; an instructive companion for the leisure hour of the one, and a necessary text-book for the training of the other.

November 1868.

" The study of the Natural Sciences, as a means of Education, is a necessity of our age. Along with the all-important instructions in the fundamental principles of morality and religion, Education should unfold and exercise the different mental faculties, and store the mind with a certain amount of general useful knowledge."—LIEBIG'S *Familiar Letters on Chemistry.*

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GEOGRAPHICAL.

GEOGRAPHY—ITS AIM AND OBJECT.

GEOGRAPHY (from two Greek words—*ge*, the earth; and *graphé*, a writing, or description) embraces all that can be known of the superficial aspects of our globe—its lands and waters, their extent and configuration, their altitude and depth, the atmosphere that surrounds them, their varied conditions and climate; and finally, the distribution of the plants and animals by which they are respectively peopled. A science embracing so wide and varied a field will readily present itself under several heads; and thus it is usual to arrange the study into Mathematical Geography, Political Geography, Descriptive or General Geography, and Physical Geography.

Mathematical Geography treats of the form, motions, and size of the Earth; of its relations to the other orbs which along with it constitute the solar system; and of the exact position of places on its surface. It thus lies at the foundation of all true knowledge of distance and dimension on the terraqueous surface; that is, the surface of the globe as consisting of land and water (Lat., *terra*, land; and *aqua*, water). *Political Geography* devotes itself to the artificial division of the land into empires, kingdoms, and

states; with all that relates to their population, manners, religion, laws, industry, commerce, and other features distinctive of such subdivisions. Relating to the social relations of man, it is of more immediate interest than the other departments; but is less stable, and subject to incessant fluctuation, according to the rise and fall, the progress and decline, of the different nationalities that compose the population of the globe. *Descriptive* or *General Geography* restricts itself to a mere account of the external aspects of the lands and waters—their extent and configuration, their scenery, life, and other obvious features, without inquiring into the causes which produce these appearances. General Geography is thus the most obvious department, and lies within the scope of every traveller and voyager who can observe, and who, observing, can describe with truth and accuracy the phenomena of his observation. *Physical Geography*, on the other hand, while it embraces all the natural conditions of the lands and waters depicted by Descriptive Geography, proceeds further to inquire into the causes which produce these results, and into the means and processes by which they are in the course of nature continually reproduced within certain limits of change and modification. Physical Geography is thus the higher department; its aim being not only to describe the outward features of the globe, but to inquire into those conditions of position, altitude, soil, heat, moisture, and the like, which govern the distribution of plants and animals on the land; and those conditions of depth, composition, and temperature, which regulate in a similar manner the distribution of plants and animals in the ocean.

Combining the preceding departments, the value of Geography, theoretical and practical, must be abundantly obvious to the most casual observer. "To determine," says a recent writer, "the relative extent of the land and water that constitute this terraqueous surface—the varying altitude of the one and the depths of the other, the climates of the one and the winds and currents that traverse the other, with the infinitely diversified mineral, vegetable, and animal productions of both—is not only a source

of high intellectual enjoyment and culture, but a task of prime industrial necessity. This globe is the sole scene of man's earthly labours—his cradle, the theatre of his life-actions, his grave! Scattered over its surface, separated by sea and mountain, enjoying different climates, and placed in proximity to different mineral, vegetable, and animal products, it is a natural necessity that different nations should trade and barter with each other. To ascertain the peculiarities of this varied surface, to learn the variety of its products—to know all, in fine, that relates to the home we tenant, and the comforts and necessaries with which it is furnished, as well as the obstacles or facilities that lie in the way of obtaining them—is the sum and substance of Geography. The observation and reasoning required in geographical research, the amount of information obtained, and the curiosity gratified by faithful descriptions of distant and diverse regions, constitute, on the one hand, its scientific or theoretical value; acquaintance with their mineral, vegetable, and animal products, now so indispensable to civilized existence, the conditions under which these occur, and the capability of the latter for naturalization in other countries, form, on the other hand, its economical or practical importance."

THE OLD AND NEW WORLDS—A CONTRAST.

The Old World, as may be learned from the study of its reliefs (surface outlines), is the world of table-lands and mountains. No continent exhibits plateaux so elevated, so numerous, so extensive, as Asia and Africa. Instead of one or two chains of mountains, like the Andes, Central Asia is traversed by four immense chains, which support vast table-lands of from 5000 to 14,000 feet in elevation, and the loftiest mountains of the globe. The extent of this elevated region is more than 2400 miles long, by 1500 miles broad. The principal mass of Western Asia is nothing but a plateau, from 3000 to 6000 feet in height. Africa, south of Sahara, seems to be only an enormous pile of elevated lands.

It has been calculated that the mountains and plateaux of Asia cover five-sevenths of its surface, while the plains occupy only two-sevenths. In Africa the high regions form two-thirds of the continent, the plains only a third.

If we call the Old World the world of plateaux, it is not because great plains are wanting there. The whole north of Europe and of Asia is merely a boundless plain; and from the shores of Holland, through Germany, Russia, the steppes of the Caspian and Siberia, the traveller may cross the Ancient World, from the Atlantic to the Pacific, for a distance of more than 6000 miles, without encountering an eminence more than a few hundred feet in height. In Africa, also, the plains of Sahara extend 2500 miles in length, by 1000 in breadth. But the situation of these plains of the Old World, under its frozen sky of the North, and under the fire of the Tropics, together with the nature of their soil (morass and sand), takes from them all their importance. The one is a frozen waste—a Siberia; the other, a burning desert; and neither the one nor the other is called to play an essential part, nor do they impress upon their respective continents their essential character.

The New World, on the other hand, is the world of plains. They form two-thirds of the surface; the plateaux and the mountains only one-third. The high lands form only a narrow band, jammed upon the western coast of the two continents. Almost the whole east runs into immense plains, which cover it, one may say, from pole to pole. From the Frozen Ocean to the Gulf of Mexico, over an extent of nearly 2400 miles, we cross only insignificant heights. From the llanos of the Orinoco to the banks of La Plata we traverse more than 3000 miles of low plains, slightly interrupted by the somewhat more elevated region of Western Brazil; they are prolonged even to the pampas of Patagonia, 600 miles further south, to the southern extremity of America. The length of the rich plains watered by the Marañon, in the direction of the current, is nearly 1600 miles; and what a contrast between the plains of the Amazon and the Mississippi and those of Siberia and Sahara! A happy climate, a

rich and fertile soil, a wonderful vegetation, prodigious resources —all, in fine, that naturally constitutes the prosperity of a country.

In this regard, therefore, the two worlds have each its own character, and form a striking contrast; so that we may say that in one of the hemispheres the plateaux and the mountain-chains predominate; while in the other, the plains give the important and essential feature of relief.—GUYOT's *Earth and Man.*

THE PLAINS OF SOUTH AMERICA.

SOUTH AMERICA is pre-eminently a land of plains. Of these, the *Silvas* of the Amazons, the *Llanos* of the Orinoco, and the *Pampas* of the Plata and its tributaries, are equally marvellous for their extent, their condition, and their products.

The *Silvas* (Lat. *silva*, a wood) are those portions watered by the Amazons that are occupied exclusively by forest trees. There is more than a million of square miles of such country, of which at least a fifth part is annually inundated. The whole is covered with thick wood, interpenetrated by innumerable creeping and trailing plants. The forest comes down to the water's edge, and, owing to the amount of rain-fall, which is excessive, the intense tropical heat, and an inconceivably rich soil, derived largely from decomposed vegetation, the conditions of life are favourable in the highest degree for certain kinds of plants and some animals, but quite unfavourable for the presence of man. The native Indians, very few in number, are sunk in the lowest barbarism, and, hitherto, it has been found impossible to establish settlements of importance by white men, although the river is navigable for thousands of miles and there are many extremely valuable products growing abundantly in the forests.

The *Llanos* (Span. plains) commence on the banks of the Orinoco, where it connects by a natural canal with the Rio Negro of the Amazons. The width gradually increases towards the Gulf of Mexico, and in this part they occupy nearly 350,000 square miles.

A very small part of the delta of the Orinoco is wooded, the rest being covered only with occasional growth. The whole lies between the equator and the tenth parallel of north latitude, and corresponds exactly in position with the Silvas, which lie between the equator and the tenth parallel of south latitude. The conditions are, however, somewhat different. The banks of the Orinoco rise gently towards the interior, but only at the rate of five feet in a mile. At the distance of a hundred miles from the river, and at an elevation of 500 feet, there is a succession of low banks about six feet above the slope, and these extend for a considerable distance, forming a sandy terrace upon open limestone rock, generally barren, but bearing some grasses and supplying water to the plains below. This barren and comparatively small part is called the "Llanos Altos" (High Llanos), and occupies the northern portion of the South American coast.

The larger and more level Llanos lie along the base of the rocky elevations, which commence with the chain of the Andes, and extend from the equator to latitude 9° N. Though more distant from the ocean, these are lower than the portions just described. They commence at an elevation of 224 feet above the sea, and only rise to 500 feet as a maximum. They are so nearly level that the currents of the rivers crossing them are imperceptible, and the waters of each are sent back towards their sources by strong winds or by the occasional floods. In these plains there are no stones or rocks, not even a pebble to be seen; and in this respect they agree with the Steppes of Little Russia and Tartary. There are, also, no inequalities except some low hills of sand rising a few yards above the common level, and some slightly elevated grounds, having an area of about a hundred square miles, only discoverable by a practised eye, and whose surface is also perfectly level. The rock is a mixture of sand and calcareous rock, but is covered with mould. Grass grows freely upon it, but there are neither trees nor bushes, except a few isolated palm trees at great distances apart, and a few bushes on the banks of the streams.

The *Pampas* (Span.) are treeless plains, extending from 20° S.

latitude into Patagonia, and occupying a total length of more than 2000 miles. The breadth varies greatly, but is in few places less than 500 miles, and sometimes more. The area included is not less than a million of square miles. Commencing within the tropics, and reaching to the 46th degree of south latitude, these plains stretch across the greater part of the south temperate zone, and are thus exposed to much variety of climate. The northern part is crossed by the tributaries of the Plata, but to the south of Buenos Ayres the rivers are fewer and smaller.

The north-western Pampas consist of slightly-undulating and dry plains, covered with luxuriant grass, and having occasionally enormous tracts occupied by thistles, which grow to the height of eight or ten feet, and which are useful as fuel. Beyond these, to the west, is an extensive pastoral district; and still beyond, an agricultural district. The surface of the former is almost everywhere a dead level; but large, shallow salt lakes occur in depressions of no great depth. The soil is good, consisting of a dark friable mould, without pebbles. There is no growth of trees, and no permanent water-courses irrigate the soil. This part of the Pampas affords admirable feeding-ground for horses and cattle, which were introduced by the Spaniards, and have replaced the llama, which was the indigenous ruminant of the South American plains. It has been estimated that one million of wild cattle and three millions of horses are fed on these plains. The agricultural district is less level than the pastoral, the soil consisting of loose sand impregnated with saline matter, and being quite unfit for the growth of the grasses. When irrigated, however, it becomes fertile, and is well adapted for fruit trees. Towards the north these lands pass into a salt desert, which is a wide plain reaching northward about 150 miles, and having a breadth of about 200 miles. The whole of this is level and smooth as a floor, and is snow-white with salt incrustations. Little rain falls, dews are unknown, and the treeless and shrubless waste is broken only by a few stunted and leafless bushes.

South of the river Saládo the land consists of a number of steplike terraces, running north and south, each slightly rising to the

south and west. These steps are generally sterile, but sometimes covered with verdure, especially in the months which in that latitude are spring. The surface is diversified by huge boulders, tufts of brown grass, and low bushes armed with spines. There are numerous brine lakes, with white, snow-like incrustations of salt. In these plains there are intersecting streams, but water fails to fertilize the soil. The transitions from heat to cold are rapid in the extreme, and very great. Piercing winds, known as "Pamperos," also rush in hurricanes across the district. The northern extremity, forming the Pampas of Buenos Ayres, is somewhat more irregular in surface, but dry. The southern part is largely occupied by swamps and lagoons, one of them having an area of more than 1000 square miles, covered entirely by aquatic plants. These swamps are liable to be flooded by the rivers, which also inundate the plains, destroying vast numbers of cattle, but leaving behind thick beds of fertilizing mud. All these Pampas, therefore, differing as they do in position, climate, soil, and surrounding circumstances, have certain characters in common connecting them with the low plains in other parts of the world, both in the great continent and in America.—*Abridged from* ANSTED'S *Physical Geography.*

THE PYRENEES.

REGARDED in their largest extent, the Pyrenees may be said to stretch from Cape Creux on the Mediterranean to the Galician coast, a distance of about 650 miles; but by the Pyrenees range is generally understood those mountains which separate France from Spain. In a straight line these Pyrenees are about 280 miles long, 50 miles broad, and comprise an elevated area of about 1100 square miles. The maximum height is nearly midway between the Atlantic and Mediterranean, where the Maladetta attains an elevation of 11,424 feet, while several peaks in the vicinity are but little below this elevation, and forty-five of them are above 9000 feet.

The range is remarkable for its wall-like form, indented by gaps, or "ports" as they are called, which give passage between France and Spain. Through about fifty of these the principal traffic between the two countries is carried on, the intricacies of many of them being known only to *contrabandistas*, who abound in the Pyrenees. There are but five carriage roads in the chain, all lying to the extreme east or west. In consequence, however, of the Pyrenees being much more southerly than the Alps, and of their vicinity to the sea, the line of congelation is higher than it is in the Alps. This has been variously estimated—Ramard fixing it at 8600 feet, and Malte Brun at 8300 on the south side of the range and at 9266 on the north side. Probably we shall not be far wrong if we assume 8700 feet, 1300 feet above the snow-line of the Alps, as the Pyrenean altitude of perpetual congelation.

Thus the grand glacial features which are characteristic of Alpine passes are frequently absent in the Pyrenees, when you are even on elevations which in the Alps are covered with ice and snow. But glaciers, snow-fields, and drifts are not wanting in the high parts, where the weather is generally so wild, and the paths so bad, as to have given rise to the proverbs,—"In the 'port,' when the wind rages, the father waits not for his son, nor the son for his father;" and, "He who has not been on the sea or in the 'port' during a storm knows not the power of God."

A remarkable and very interesting feature in the Pyrenees are the *basins*—"cirques" or "oules," are their local names. They are situated in the transverse valleys lying between the buttresses of the principal range, and are generally surrounded on three sides by lofty walls of rock opening into the valley by a narrow gully. The scenery of these cirques is peculiar, possessing much sublimity with great pastoral beauty.

The geology of the Pyrenees has not been so thoroughly investigated as could be desired. Enough, however, has been done to inform us that the primitive rocks occupy but a very small portion of the chain—running in narrow bands parallel to the main direction. The secondary and transition rocks compose the great

mass of the mountains, and consist of slaty schists and crystalline limestones, containing ores of iron, copper, argentiferous lead, and zinc, and near Cardona two remarkable deposits of rock-salt. In great mountain chains, the lower elevations are generally composed of secondary and transition rocks, through which the granite pierces, and forms the highest mountain peaks. In the Pyrenean system the case is different; for the highest peaks consist of calcareous beds, which belong to the chalk and lower tertiary formations.

The dislocations in the Pyrenees are intimately connected with thermal springs, which form a prominent feature in the physical geography of these mountains. Their number is extraordinary, no less than 253 being known; and there is a great and almost romantic interest in the fact, that they have for many centuries been ceaselessly pouring forth an almost unvarying quantity of water, for the most part of a high temperature, and in many cases nearly approaching ebullition. Remarkable, too, is the fact that these waters, rising through vast earth and rock masses, undergo no change in their solid or gaseous constitution. The same mineral water which poured forth its medicinal virtues to the Gauls and Romans still flows, without change or stint.

Another remarkable property of these mineral springs is, that their great heat should apparently not be due to direct volcanic action. The phenomena of these perpetually hot flowing waters is probably due to the same agency that upheaved the granite through the axis of the Pyrenean chain; for most of them gush out at the junction of the primary and stratified rocks, and where the strata afford evidence of having been rent by violent convulsions. It is further worthy of notice, that as we proceed eastward, where the granite rocks preponderate, the springs are warmer than those rising in the western portion of the chain. But while these laws are general, the curious and perplexing phenomenon may be witnessed of springs issuing from dislocations within a few yards of each other, not only of a totally different mineral composition, but of highly opposite temperatures; as, for example, at Eaux Bonnes, where a perfectly cold spring rises

close beside one of a sulphurous nature, having a uniform temperature of 97° Fahrenheit!

The Pyrenean valleys are much lower than the Alpine; few being more than 2000 feet above the level of the sea, while those in the Alps are rarely less than double that height. Thus the mountains in the Pyrenees, when seen from the valleys, frequently assume a more imposing appearance than those in Switzerland of higher elevation. The streams, not turbid like those in Switzerland, but clear and bright, which gush from every hollow and water every valley, impart an exquisitely bright verdure to the lower lands, nourishing at the same time an almost endless variety of lovely flowers. These are not, however, confined to the valleys; for, like all mountainous districts, the flora of the Pyrenees presents an epitomé of the vegetation from the equator to the poles. In the valleys and on the slopes of the mountains a great quantity of Lombardy poplars flourish; as we ascend, Spanish chestnuts, oak, hazel, mountain ash, alder, sycamore, and magnificent birch trees abound. Higher still we come to the dark pine forests, which form a prominent feature in the Western Pyrenees; and beyond that lies the region of the dwarf juniper, the saxifrage, and other Alpine species, which creep up to the verge of perpetual snow.

Among the wild animals frequenting the Pyrenees may be mentioned two species of bear, the wolf, the izzard or chamois, and the bouc-stein or goat of the rock; and though the former of these are gradually becoming scarce, the enterprising hunter may still find them in unfrequented portions of the forest and on the higher mountains.—*Abridged from* WELD's *Pyrenees.*

THE SCENERY OF NORWAY.

THE scenery of Norway, which is, of course, the result of its physical peculiarities, may be divided into three classes,—that of its *valleys*, its *fields*, and its *fiords*. The first resembles, on the whole, that of the lower parts of the Alps; often picturesque,

sometimes grand, and occasionally highly pleasing, especially near the lakes. The second is in some degree peculiar to this country, and must disappoint many who are not prepared for its singularity. These fields, or *fjelds*, are often interminable wildernesses, undulating, or varied only by craggy heights devoid of majesty, rarely attaining the snow-line, but spotted over with ungainly patches of white. Von Buch, all whose descriptions betray a very ardent determination to exalt the scenery of Norway, compares the aspect of Sneehättan to that of Mont Blanc as seen from the Breven! But it would be difficult, I should think, to find a seconder for such a judgment. The height of the summits of Norwegian mountains above the table-land which forms their base is usually too small to give them much effect. But the scenery of the fiords and profound valleys, which may be considered as the mere prolongation of them, is the really distinguishing feature of Norway as regards the picturesque. It is analôgous, indeed, to that of the west coast of Scotland, but on a scale of much greater grandeur; and, by those who have fully appreciated, with due leisure, and under favourable circumstances of weather, the magnificent scenery of our Hebrides, including Orkney and Shetland and the western firths, the praise will not seem small. The depth of the inlets, the precipitousness and continuity of the cliffs, the number and singular forms of the rocks and islands, occasion a succession of prospects the most varied and surprising. Then the frequent appearance of perpetual snow, and the occurrence of glaciers close to the sea, give a vivid contrast to the luxuriance of vegetation and the warm tones of colour which, in fine weather, commonly prevail.

But of all the contrasts which Norway presents to other mountainous countries, the abundance of running water is perhaps the most striking to a stranger. Running water of a bright and sparkling green is seen on every side, at least in the valleys. It pours over cliffs often in a single leap, but more frequently and more effectively in a series of broken falls, spreading laterally as it descends, and rivetting the imagination for a long time together in the attempt to trace its subtle ramifications. The sound is rather

a murmur than a roar, so divided are the streams and so numerous the shelves of rock tipped with foam; whilst a luxuriant vegetation of birch and alder over-arches the whole, instead of being repelled by the wild tempest of air which accompanies the greater cataract. At other times, threads of snow-white water stretch down a steep of 2000 feet or more, connecting the *field* above and the valley below. They look so slender that we wonder at their absolute uniformity and perfect whiteness throughout so great a space—never dissipated in air, never disappearing under *debrís;* but on approaching these seeming threads we are astonished at their volume, which is usually such as completely to stop communication from bank to bank.

The source of this astonishing profusion of waters is to be found in the peculiar disposition of the surface of the country, so often referred to. The mountains are wide and flat, the valleys are deep and far apart. The surfaces of the former receive and collect the rain, which is then drained into the narrow channels of the latter; and as the valleys ramify little, but usually preserve single lines, and are wholly disconnected from the *fields* by precipitous slopes, it follows that the single rivers which water those valleys represent the drainage of vast areas, and are supplied principally by streamlets which, having run long courses over the *fields*, are at last precipitated into the ravines in the form of cascades. But there is also another reason for this striking abundance of water. The fall of rain is large, if not excessive, over a great part of Norway. It is also, no doubt, greater on the *fields* than in the valleys of the interior. The height of the mountain-plateaux is such as to be covered, more or less, with snow during two-thirds of the year or more. During this period the rivers and cascades are comparatively, and in many cases absolutely, dry. The vast accumulations of autumn, winter, and spring are thawed during the almost constant warmth of the long summer days. In this season alone the interior of Norway is usually visited, and we see the result in the amount of drainage concentrated into that brief season. In the Alps, no doubt, a similar cause is active; but the comparative rarity of

the cascades is explained by the absolute want of table-lands, and the infinitely ramified character of the valleys. In the Pyrenees, which have a still more ridge-like character than the Alps, the cascades are more numerous, but yet far more scanty.—J. D. Forbes—*Norway and its Glaciers.*

MOUNT HECLA, ICELAND.

The volcanic region which we were now entering is about twenty-five miles long, and sixteen broad at its widest part. Hecla is the name given to the central and loftiest of several parallel ridges. It is twelve miles in length by three or four in width. The subordinate ridges lie along its sides like gigantic steps. Many of these seem once to have been active volcanoes, and stand to Hecla in the same relation as the Monte Rossi to Etna. All have steep, smooth sides, formed of loose sand and decomposed rock, like those of a sifted ash-heap. Several streams of lava, of different ages, flow down among them from the craters to the sides of the mountains. We rode for an hour and a half among these ridges, getting gradually higher and higher, till we came up with the lava of 1845, beyond which there was nothing but the central ridge, Hecla itself, to be climbed. We crossed a portion of the lava—a very distressing but fortunately short piece of work—and then, keeping near to its main stream, struck obliquely up the side of the mountain. The ascent offered no difficulty, but was very tiring on account of the steepness and the heat, being now the 28th of August. The snow was in excellent condition for walking on;—we wished there had been more of it. About four hundred yards from the top we came to the crater whence the lava of 1845 issued. It was still smoking. Thence the stream descended in a vast volume down the steep mountain-side to the plain, taking a westerly direction till it reached the level ground a little east of Hals. Then it stopped before coming to the river Rángá. It seemed to

be a mass nearly equalling that which descended from the Val del Bové of Etna in 1851. The top, which we reached after four hours' travel, is a ridge about half a mile long, depressed at the centre, with a crater at each end. Its direction is east and west. The western crater is broken down on its western side, and partially filled up with *debris*. The bottom is filled to a great depth with snow melted by the hot vapours which rise from the caverns and from various small orifices in the sides. Moss grows on the side opposite the opening, despite the extensive incrustations of sulphur. On the middle of the ridge is a hot spring, the ground about it wet with steam rising from it. The eastern crater is the more picturesque, from the bright red colour of the rocks. Numerous jets of steam issue from its sides. Snow lies here in great quantities. A great deluge of lava blocks has been ejected from this crater in a southerly direction.

The few clouds which hovered over the mountain in the early morning had quite cleared off, and the view was splendid. It must be the most extraordinary to be seen in any part of the world. To the east and south you look over a waste of glaciers, snow-fields, and lava, silent and lifeless. The ridges are generally flattened, and at this season had but little snow upon them. The glaciers also are flat and dirty, with little beauty of colour. I could see no ravines. This, I suppose, is due to the fact that these *jökuls* are not glaciers, properly so called, but fields of snow and ice—the term "jokul" being loosely applied to any tract where there is snow. To the north the chief object was the muddy Thiorsá, fed by numerous tributaries; and beyond, the mountains and glaciers near the Geyser. To the north and west stretched the plain over which we rode yesterday, green and fertile-looking, streaked with dark lava-streams. Nothing could exceed the beauty of the soft grays and blues in the shadows among the hills—a peculiar effect which we have already observed in other places. The height of Hecla is 5000 Danish feet. Of the two summits, the eastern is rather the higher and more precipitous.—J. W. Clark—*Notes of Travel in* 1860.

REGIONS OF THE HIMALAYAS.

THE Western Himalayas may be divided into three regions:—*First*, the lower or Sewalik region, comprehending the lesser ranges which border the plains of India, and differ but little from the latter in climate and natural productions. *Second*, the middle or forest region, embracing the highly cultivated and forest tracts, where nature wears the garb of the temperate zone. *Third*, the upper or snowy region, comprising the table-lands and mountains of Thibet, Ladakh, &c., extending from the stunted birch at 8000 or 9000 feet above the level of the sea to the limits of perpetual snow. The fauna and flora of this region are distinct from the foregoing, inasmuch as its animals seldom descend to the lower zones unless driven by the rigours of winter, and its plants present an arctic facies (Lat. aspect or appearance). The geological features vary much from the upper and mid-tertiary beds of the lower hills to the secondary and azoic rocks of the middle and upper regions. But what gives a most characteristic appearance to each of these belts is their flora.

Although perhaps not so well defined as those of the Andes, still the tropical, temperate, and arctic forms preserve their position with marked regularity. Thus, the naturalist from Kalka, at the foot of the Sewalik range, on his journey by the hill road to Simla, can trace without difficulty the gradual botanical changes from the stunted palm-tree to the gnarled oak, on to the stately pine, and thence to the lichen and rhododendron. The journey through the mountains to Simla and other hill stations is usually performed by a litter, sedan-chair, or on horseback. The stages are easy, and there is tolerably good accommodation at the various halting-places. So marked are the gradations of climate, and so rapid, that from the torrid heat of the plains and 90° Fahrenheit in the shade one may be easily transported in forty-eight hours to a temperature below zero. The scenery of the lower ranges is exceedingly striking and beautiful. I felt as if suddenly conveyed to the temperate zone, and more especially when the stately

cheer-pines, wild roses, jessamines, violets, and dandelions, met my view; though there was still an admixture of strange plants and trees peculiar to the region, then quite unknown to me—such as the coral tree with its gorgeous red flowers, and oaks with laurel-shaped leaves.

The mountains forming the lesser ranges which border on the plains of India present in general great broken chains, running for the most part parallel, and from east to west, separated by broad valleys called *khuds*. In the interior this regularity is less observable, and the mountains, instead of rounded summits, have a bold and well-defined outline. The rainy season commences on the lower ranges towards the end of June. After a few showers, vegetation springs up almost magically. Mountain-sides, that before appeared bare and desolate, become clothed with luxuriant vegetation in a few days. The fir crowns the mountain-brow, while in the valleys flourish oak, walnut, and mulberry. Cherries, apricots, and plums are ripe before the commencement of the rains. The monsoon ceases toward the end of August, and is succeeded by clear skies and a mild temperature. About the middle of November the cold weather sets in, and the distant peaks are then tipped with snow. In January it often falls on the ranges next the plains, and for six weeks at this season the climate is almost British. From April to June the thermometer averages from 76° to 80° in European houses; but, though at mid-day the heat is often very oppressive, the mornings and evenings are cool and agreeable.

The soil of the mountains and valleys is very productive. On the mountain-sides small terraces are made, one above another, and irrigated by turning on the nearest stream, which, if distant, is conveyed by means of hollow trees. Rice, wheat, barley, Indian-corn, and batu constitute the staple products of this region. Every valley, or khud, has its little stream, whose banks are covered with shrubs and trees, sometimes so dense as to be impenetrable; thus contrasting with the higher elevations, where we find the rhododendron and forest trees in all their magnificence and beauty. As the productions of the Himalayas vary, so are

there varieties in their scenery. Each region has an attraction peculiar and distinctive, whether among the tangled jungle of the lesser ranges, or high in the region of forest, or still further up among the stunted birches, upon the confines of eternal snow.—Dr. Adams—*Wanderings of a Naturalist in India.*

THE ISTHMUS OF PANAMA.

The Isthmus of Panamá lies between the 4th and 10th parallels of north latitude, and the 77th and 83rd of west longitude. Its least breadth, from sea to sea, is 27 miles; and its configuration that of a bow, the coast of the Caribbean Sea forming the convex line, and that of the South Sea the concave. Bounded on the north and north-east by the Atlantic, on the south and south-west by the Pacific, on the east by the rivers Atrato and San Juan, and on the west by the Republic of Costa Rica, it presents, including the adjacent islands, a surface of 34,000 square miles—an extent of territory nearly equal to that of Portugal.

The coast on the Atlantic side extends from Costa Rica to the River Atrato—360 miles; and is on the whole rather low, consisting as it does of a succession of lagoons, river mouths, and bays. It possesses, however, several ports and open roadsteads with excellent anchorage. The line which the coast of the Pacific describes, extending from the River Chiriqui Viejo to the mouths of the San Juan, is 660 miles in length. The shores are, generally speaking, bold and rocky as far as Cape Corrientes, but thence to Chirambira flat, rising only a few feet above the sea-level. On this side also there are several ports and natural harbours.

The coasts are fringed with numerous islands. The largest on the Atlantic side are the Escudo de Veraquas, and those situated in the Lagoon of Chiriqui; others of a smaller size, generally known to the voyager by the name of Cayos or Keys, are scattered along the shores, and form occasionally, as in the case of the Sombaloes, regular chains. All, however, are but thinly peopled, and at present are not much frequented by foreign

vessels. Of greater importance are the islands on the Pacific side. Several groups are situated on the south-western coast of Veraquas; and another cluster, of which Coyba, Gobernadora, and Cebaco are the largest, in the Bay of Montijo. Coyba—or Quibo as it is incorrectly spelled by foreigners—the most extensive, is 24 miles long, 14 broad, and well supplied with wood and water. The Pearl Islands—so called from the pearls annually collected on their shores—form a little archipelago at the entrance of the Bay of Panamá; and a smaller, but scarcely less important group, in the immediate vicinity of Panamá (of which Tobago is perhaps the most delightful), is celebrated for its beauty and tropical luxuriance.

A country like the Isthmus, visited by such heavy rains, abounds in rivers. Not counting the smaller and periodical streams, their number cannot fall short of two hundred. Of those emptying themselves into the Atlantic, the Belen, Veraquas, Chagres, and the nine-mouthed Atrato are the largest; among those flowing into the Pacific, the Chiriqui, Tavasara, Santa Maria, Rio Grande de Nato, Bayano, and San Juan. They are mostly shallow, and only navigable in flat-bottomed canoes. The rivers Atrato and San Juan approach each other within a distance of four hundred yards, nearly separating the Isthmus from the continent of South America, and forming the natural and political boundary of the country under consideration. The Atrato or Darien is described as a river full of shoals, dangerous to pass even for canoes. If small steamers could navigate it, this part of the Isthmus might be the most practicable for cutting a canal. Another close approach of rivers exists between the Chagres and the Rio Grande de Panamá, of which due advantage has been taken in some of the projects for connecting the two oceans. Most of the rivers have deltas, which in many instances have the appearance of islands. Their vegetation is a mixture of littoral (Lat. *litus*, the shore) and inland plants, and often exhibits species of the higher mountains, by which the remote sources of the waters may be traced.

The Isthmus is not remarkable for high mountains. The chain of the Andes, after traversing the continent of South America,

diminishes in approaching it, and in the province of Panamá is hardly recognizable in a ridge of hills which seldom exceeds a thousand feet in height. The statement that the Cordillera is entirely broken in the vicinity of Cupicá in Darien rests on obscure authority. A new series of mountains seems to commence at Punta de Chame, which attains a greater elevation on entering the province of Veraquas, and in the volcano of Chiriqui produces the most elevated part of the Isthmus, a peak 7000 feet high. This ridge, as indeed all the inland heights are, is covered with tropical forest-growth of extreme luxuriance and beauty. The districts on the coast of the Pacific abound in grassy plains (*llanos*) of great extent, which, in affording pasture to numerous herds of cattle, constitute the principal riches of the country. I have been informed, by persons on whose veracity I can rely, that from the tops of the mountains between Bocas del Toro and the town of St. David both oceans may be seen at once.

The geological formation is as yet imperfectly known. In some parts auriferous (gold-bearing) porphyries and granites prevail, partially impregnated with iron pyrites and enclosing veins of felspar and basalt; in others the rocks are chiefly of a slaty or schistose character. Auriferous quartz is observed in different places; and gold is obtained from the drifts of the streams and rivers. Copper, iron, and gold are found all over the country; and, indeed, from the quantities of gold collected by the earlier settlers the Isthmus received the name of Castella del Oro; but when the superior wealth of Peru and Mexico became known this appellation seems to have fallen into disuse. The working of iron and copper is impracticable, on account of the high price of labour, and will remain so as long as the country is so thinly peopled. Volcanoes, now extinct, exist in different parts. The highest is that of Chiriqui, already mentioned; another of considerable elevation, about three thousand feet high, the Jananò, is seen at Cape Corrientes in Darien; and several others of great size are reported to exist in Veraquas. But although without active volcanoes, the Isthmus is by no means free from earthquakes. They occur mostly during the dry season,

from January till May, and consist of undulating movements coming from the west, and having apparently their origin in Central America. Hot springs are to be found in various parts of the country, and are much used by the natives as medicinal baths.

The geographical position of the Isthmus, the almost entire absence of high mountains, and the vast extent of forests and other uncultivated parts, tend to produce a hot and rainy climate; which, nevertheless, with the exception of a few localities such as Chagres, Portobelo, and Chirambira, is healthy and more favourable to the constitution of the Caucasian race than that of most tropical countries. The most prevalent disease is intermittent fever, which makes its appearance during the change of season. The seasons are regularly divided into wet and dry. The rains are expected with the new moon in April, and continue eight months till the end of December. Slight at first, the rain gradually increases, and is fully established towards the end of May, when it falls in torrents, sometimes for days in succession, and is mostly accompanied by thunder and lightning of the most terrific description. Towards the end of December the violent rains are less frequent, the clouds begin to disperse, and with the commencement of the new year the north-west wind sets in. An immediate change follows. The air is now pure and refreshing, the sun brilliant, the sky blue and serene, hardly a cloud is to be seen, and the climate displays all its tropical beauties. The heat, although much greater—ranging from 75° to 94° Fahr.—is less felt, as the atmosphere is almost free from moisture. The rays of the sun, however, are very powerful; and the rise of the thermometer to 124°, when at noon exposed to their influence, is no uncommon phenomenon. These statements, however, have reference only to the lower regions; on the higher mountains the climate is modified, and on account of its lower temperature better adapted to the constitution of the white man.—*Abridged from* SEEMAN'S *Narrative of the Voyage of H.M.S. Herald.*

BRITISH COLUMBIA.

We had now seen a great portion of British Columbia and Vancouver. We had travelled through the former from Tête Janne Cache by the Thompson to the mouth of the Fraser, and again through the heart of the country to Cariboo. We found the country abounding in mineral wealth. The extent and richness of the gold fields, added to every month by fresh discoveries, would alone be sufficient to render the colony one of our most valuable possessions. But the indications that many other of the most valuable minerals will be found in British Columbia, as in the neighbouring state of California, are strong. At present, however, every other pursuit is put aside for that of gold, and the real mineral wealth of the country is little known. Coal, however, crops out at Alexandria, Similkameen, and Burrard's Inlet. In the sister colony of Vancouver are the magnificent beds of coal, which have been already extensively and most successfully worked at Nanaimo. The timber of British Columbia is, of its kind, unequalled. The Douglas pine, with its straight uniform trunk, exceedingly tough and flexible, furnishes the finest masts and spars for the largest vessels. These trees often attain a height of upwards of three hundred feet, with a diameter of ten feet. The white pine and the gigantic cypress—the latter exceeding even the Douglas pine in size—grow together with it in vast forests, yielding an almost inexhaustible supply.

But perhaps the most striking feature in the resources of British Columbia and Vancouver Island, is the extraordinary number and variety of the fish which frequent the shores and swarm in all the rivers. In the spring two kinds of salmon ascend the Fraser, millions of "hoolicans" crowd into its mouth, and shoals of herrings enter every inlet. The hoolican is like a sprat, but a little larger, and is a very delicious fish, rich in oil. Flocks of gulls hovering over the shoals announce the arrival of these fish; and their extraordinary numbers may be imagined from the way in which the Indians take them. The river is

literally alive with fish; and the native fisherman carries a long piece of wood, armed with sharp-pointed wires on each side, like the teeth of a rake. This he sweeps through the water as he sits in his canoe, after the fashion of a paddle, and at each stroke brings up a row of hoolicans impaled upon the spikes. Three or four species of salmon continue to ascend the river in succession during the summer and autumn; and in the winter a fifth variety makes its appearance in the harbours and inlets along the coast. We saw some of fifteen to twenty pounds each caught in the harbour of St. Juan in the month of December. Salmon of some kind is thus in season all the year round. Trout abounds in the mountain streams and lakes, and the sturgeon frequents the deeps of the Fraser. In Burrard's Inlet oysters are found in great abundance; and, in fact, everything good in the way of fish seems to be collected in this, so far, highly favoured country.

From the richness and extent of its pasturage, and the dryness of its soil and climate, British Columbia offers great advantages to the breeder of stock. But there are certain drawbacks, the principal of which is that an immense extent of country would be required by each stock farmer. The only grass is the "bunch-grass." It covers the terraces of the Fraser, and the rolling swells and mountain-sides of the central region. Growing in the separate "tufts" from which it has taken its name, it fixes but a slight hold upon the light, powdery soil with its slender roots. Horses and cattle pull much of it up in grazing; and sheep, which thrive equally upon it, crop the delicate plant so closely that it frequently does not recover. In this way the Lilloet-flats, which were once celebrated as rich feeding-grounds, have now become bare, dusty plains, on which a few scattered plants of wild sage and absinthe still remain, where the bunch-grass has been destroyed. The facts, too, that the bunch-grass requires three years to come to perfection and fully recover after being eaten down, and that, from its mode of growth in distinct tufts, the ground is really but scantily covered with herbage, confirm the belief that for a stock farm to be successful its range of pasturage must be very extensive. But there is room enough

now; and any who may devote themselves to the raising of sheep and cattle will certainly reap a rich harvest of profit.

The extent of agricultural land in British Columbia is very limited indeed. With the exception of a small district between the south end of the Okanagau Lake and the Grand Prairie, on the road from thence to the Thompson River; a few other patches of good land in the interior; and the delta of the Fraser, which is covered almost entirely with dense forest and exposed to the summer floods, it is a country of rocks, gravel, and shingle. The surface of the country east of the coast range of mountains consists principally of a high table-land, from which rise up mountains and hills, indented by the valleys of the Thompson and Fraser and their countless tributaries. These valleys are deep and narrow, and their sides generally steep. On the table-land the night frosts, prevalent throughout the summer, preclude the cultivation of almost every description of produce. In the valleys the land is generally very dry and sandy, or stony, and, unless some approved system of irrigation and manuring is adopted, would yield a wretched return.

In all the instances we saw where attempts had been made to raise crops of cereals on the terraces of the Thompson and Fraser, or indeed anywhere in the region of shingle and gravel, they had failed. Cabbages, and vegetables of similar kind, if well watered, seemed to flourish very well; but the oats and barley were short in the ear, and the straw weak, stunted, and miserable. Water is sufficiently abundant, but the soil of the irrigated tracts is so extremely light, and in most parts underlaid by such a depth of gravel and shingle, that the water percolates through as through a sieve, and the streams disappear without spreading over the surface. The decay of the sparsely growing bunch-grass cannot have rendered the land rich in vegetable mould. Occasional fertile spots, of a few acres in extent, occur on the margin of the rivers, as along the north and south branches of the Thompson above Kamloops. There are also patches of good land in the vicinity of William's Lake, Beaver Lake, and Alexandria, which have proved very productive. But these rich bottoms and alluvial

lowlands are striking exceptions to the general character of the country. British Columbia, rich beyond conception in many ways—in minerals, timber, and fish—is *not* an agricultural country; the lightness of the soil, the absence of great flats, the extreme drought of summer and the arctic cold of winter, ever preventing development in this department of industry.—*Abridged from* MILTON *and* CHEADLE'S *North-West Passage by Land.*

THE LANDES OF BOURDEAUX.

THE term *Lande*, literally signifying heath or heathland, is applied, in particular by French writers, to those extensive areas of sand-drift which stretch southward from the mouth of the Garonne along the Bay of Biscay, and inwards towards Bourdeaux—hence generally spoken of as the "Landes de Bourdeaux." They are extensively planted with the sea-pine (*Pinus maritimus*), on the seaward side, but stretch away inland in heath-undulating plains, chiefly occupied with sheep-runs. The following facts connected with this peculiar tract are gleaned from a recent work ("The Pyrenees") by Mr. C. R. Weld, who traversed the country in 1859:—

Nothing more dreary than those apparently interminable wastes. Your passage across them suggests ideas of the ocean, with this great difference, however, that whereas the latter is never at rest, the vast tract of the Landes, comprising about a million and a half acres, except when swept by hurricanes, presents a still and monotonous surface. The soil is sand—endless sand—vertically as well as superficially. Artesian wells have been sunk to the depth of nearly 1000 feet, and then a scanty supply of wretched yellow water has been the only result. As may be supposed, the lives of the inhabitants of this unpromising region are short, feverish, and sickly. The Landais have a proverb—

"Tant que Lande sera Lande
La pellagre te demande;"

said pellagre being a fatal disease occasioned by malaria and bad water.

Amidst these wastes, lying to the east of the pine forests which fringe the sea-coast, the Landais, who are with a few exceptions shepherds, spend the long summer days with their flocks of sheep, each animal being as well known to them as their dogs. The Landais shepherd is a primitive being, fond of solitude, rarely venturing near the railway—when he does, he gazes wonderingly at the rushing train;—so, to see him, you must penetrate into his wilderness. There, amidst the great wastes, clothed in sheep-skins and wearing the Navarre cap, you will find him mounted on tall stilts—become, from long habit, like a second pair of legs, for he has been accustomed to them from childhood—probably knitting while his flock crop the scanty herbage. There he stands resting upon his pole, a strange tripod-looking figure—stranger still when he strides across the Landes in hot haste after a wandering sheep. He has a small hut, sometimes a wife, who aids him in cultivating a small patch of ground, from which he obtains a little corn and a few vegetables. A miserable existence is this; but the dawn of brighter days has, we may hope, appeared for the poor Landais.

After innumerable futile attempts to reclaim and fertilize portions of this desert, two joint-stock companies have succeeded in reclaiming a considerable tract of the Plaine de Cazaux. Sheltered from the prevailing west winds by the great maritime pine forest (to be afterwards noticed), the Plaine de Cazaux, situated to the east or leeward, is not so liable to the destructive effects of the great sand storms as other parts of the Landes. Rice, tobacco, and the Jerusalem artichoke, for which the soil is admirably adapted, are the chief crops. The improvements are in a great measure due to M. Pierre, an agricultural genius, who, having studied agriculture, and particularly drainage, under scientific teachers, devised a system of reclaiming and husbandry which has been very successful. Prosperity is rapidly following these improvements; and, what is better, malaria no longer poisons the reclaimed districts. The peasantry enjoy better health, and M. Pierre firmly believes that the terrible pellagre will soon be unknown in the Landes.

The great pine forest of the Landes, locally called *Pignadas*, extends from the Adour to the Gironde, and is also an extraordinary monument of man's skill and perseverance. Prior to 1789, this forest area was

> "A bare strand
> Of hillocks heaped from ever-shifting sand,
> Matted with thistles and amphibious weeds,
> Such as from Earth's embrace the salt ooze breeds."

The sand was so fine as to be wafted by the faintest breeze, while the great sea-storms raised huge sand waves, which overwhelmed vegetation, and rolling inland, frequently carried desolation and destruction among far distant villages and fields. Such was the state of this part of the country when M. Bremontier, an officer in the Government department of the Administration of Forests, conceived the idea of erecting wattled hurdles and boards near the sea, so as to break the storms; and sowing in narrow zones, leeward and at right angles to the prevailing winds, seeds of the *Pinus pinaster* and common broom, in the proportion of five pounds of the former to two of the latter per acre. The area sown was then covered with pine branches, care being taken to prevent their being blown away by pinning them to the ground. In about six weeks, the broom seeds produced plants six inches high, which attained the height of two feet by the end of the year. These now afforded excellent shelter to the pine plants, which were but four-inch striplings, and under their fostering protection the pines grew and flourished, until, at length, with an ingratitude not, unhappily, confined to the vegetable world, they suffocated their infantine protectors, and rose high, defiant of the raging sand storms. So effective was M. Bremontier's process, that in 1811 a Commission appointed by Government to examine the Landes reported that 12,500 acres were covered with thriving and profitable pines: and the Landais who had lived to see their howling wastes clothed with far-stretching forests, were enabled to gain a livelihood less precarious and perilous than that obtained by fishing in the stormy waters of the Biscayan Bay.

Twenty-five years passed, and then the hand of man was busy

among the pines. Good as the pinaster is for domestic purposes, it is far more valuable for the great quantity of resin, tar, turpentine, and lamp-black which it produces. As you ride through the pines you will meet the resin-gatherers—*resiniers*, as they are called—who, during the summer months, live in the forests; for the most part a rude set of men, speaking a strange *patois*, from which, however, you may glean some information. When the resin harvest is at hand, the resinier goes forth provided with a short ladder and a curved axe. Where the tree is large enough for operation, a longitudinal groove is made in the trunk, down which the resin flows, and is caught at the bottom of the stem in a little trough, fashioned in a few moments from the bark removed by the cut. Weekly the wound is re-opened, but not widened; and the operation is renewed yearly, until the entire trunk is scored in such a manner as to make you wonder how the maimed bole can support the superincumbent weight. But, stranger still, the pine is not injured by the sooring process; for, if the operation be judiciously performed, by the time that the resinier has gone round the tree, the first wound has healed, and the trunk is ready to be bled again. Wonderful, too, is the quantity of resin which comes from those bountiful trees! When the pines have been scored and re-scored, those destined to make tar—called *pins perdus*—are cut down, and the tar extracted by burning the roots and thicker portions of the trunk very slowly in cavities made in the sloping ground.

This reclamation of the Landes of Bourdeaux points an important lesson to other countries where extensive tracts of loose shifting sand-dunes occur along the sea-coasts, and remain as yet little better than profitless or scanty sheep-runs.

A PEEP AT A LAPLAND CAMP.

We at length extricated ourselves from the wood, and crossing the stream, saw the Lapp camp before us on a dry and pleasant grassy space, about two and a half English miles from the sea.

Some piles of sticks, and mounds which seemed like no human habitation, first attracted attention. The piles of sticks form (as we found) a sort of skeleton shed, which can be enclosed in bad weather by a kind of rude tarpaulin. They contain barrels, clothes, and many nondescript utensils and stores, which in fine weather are exposed suspended from the bare poles. Two low round mounds of turf, overlaid with sticks and branches in a most disorderly fashion, composed the habitation of a multitude of men, women, and especially children, who seemed at first sight to be countless. Their appearance—uncouth, squalid, and diminutive in the extreme—was, I thought, decidedly unprepossessing. But an attentive survey brought out some more favourable features. The countenance was altogether unlike any I had seen, but by no means devoid of intelligence, and even a certain sweetness of expression. Notwithstanding that our party was tolerably numerous, they exhibited no signs either of distrust or of shyness; and whilst some of them entered into conversation with one of the gentlemen from Tromsö, who knew a little of their dialect, and others went, attended by several small, active dogs, to fetch some reindeer for our inspection from the heights, the greater part remained quietly engaged in their huts, as we had found them, quite regardless of our presence. On inquiring into their occupation, we were surprised to find them possessed of some excellently printed and well-cared-for books, particularly a Bible in the Finnish tongue, and a commentary, each forming a quarto volume. We found some of them also engaged in writing. This was a matter of surprise, where we had been led to expect something approaching to barbarism. And we had soon a proof that their pretensions to religious impressions were not merely theoretical, for they positively refused to taste the spirits which were freely offered to them, and of which our party partook; though it is well known that excessive and besotting drunkenness used to be the great sin of the Lappish tribes, and still is, of those who have not been converted to habits of order and religion by the zealous efforts of the Swedish missionaries.

The characteristic composure of the people was well shown in a young mother with rather pleasing features, who brought her infant of four months old out of one of the huts, and seating herself on the sunny side of it, proceeded in the most deliberate way imaginable to *pack up* the child for the night in its little wooden cradle, whilst half-a-dozen of us looked on with no small curiosity. The cradle was cut out of the solid, and covered with leather, flaps of which were so arranged as to lace across the top with leather thongs; the inside and the little pillow were rendered tolerably soft with reindeer moss; and the infant fitted the space so exactly that it could stir neither hand nor foot, yet made little resistance to the operation. A hood protected the head, whilst it admitted air freely. When the packing was finished, the little creature was speedily rocked asleep. The elder children were inquisitive, but far from rude, and played nicely with one another.

The Lapp hut is formed interiorly of wood, by means of curved ribs, which unite near the centre in a ring, which is open and allows free escape for the smoke, the fire being lighted in the centre of the floor. The exterior is covered with turf. The door is of wood on one side. The inmates recline on skins on the floor, with their feet towards the fire; and behind them, on a row of stones near the wall of the hut, are their various utensils. Their clothing—chiefly of tanned skins and woollen stuffs—looked very dirty. Their whole wealth consists in reindeer. The two families who frequent this valley possess about seven hundred deer. We saw perhaps about one-fourth of that number. A few of them were driven for our inspection into a circular enclosure of wooden paling, where they are habitually milked. One of the men dexterously caught them by the horns with a *lasso*, or noose. The deer are small; but some of them carry immense branching horns, the weight of which they seem almost unable to support. At this season (midsummer) their long winter coat of hair came off by handfuls. They make a low grunting noise, almost like that of a pig. Their milk is very small in quantity, but excessively rich.—J. D. FORBES—*Norway and its Glaciers.*

THE ALPS.

THE Alpine chain includes the highest land in Europe. It extends from France eastwards to the Balkan for a distance of more than five hundred miles from west to east, and has a breadth gradually widening from eighty miles in its western to as much as two hundred miles in its eastern portion. The loftiest part of the chain is near its narrowest part. The highest or culminating peaks are nearly adjacent, though separated by a deep valley. They are Mont Blanc and Monte Rosa. The former is estimated at 15,784 feet, the latter at 15,223 feet. There are many practicable passes, the highest of which, the Alder Pass, is 12,461 feet. Another, the Col du Geant (11,146 feet), crosses near the western extremity of Mont Blanc. This portion is jagged with numerous peaks, pyramids, and needles, of altered rock. There are in the Alps, besides Mont Blanc and Monte Rosa, at least one hundred detached mountain peaks upwards of 10,000 feet high, all of which are constantly covered with snow. Few of them are inaccessible, but many are both difficult and dangerous of approach. They are surrounded by and buried in snow. Vast sheets of frozen snow or glaciers come down from the higher valleys into the country below, widening as they descend, and often connecting with other frozen streams, just as the waters of adjacent valleys combine and perform the rest of their downward course together.

Although inferior in height to some of the great mountain chains of the Earth (the Himalayas and Andes), the Alps afford magnificent and picturesque scenery, and exhibit all the most prominent physical features of lofty mountains. They rise in Switzerland from a plateau of only moderate elevation, and on the south side they shoot up at once to the sky from the plains of Lombardy. There is an extension towards the south and west to the Mediterranean, under the name of Maritime Alps. Nothing can be imagined more perfect than the mixture of the wildest and most savage scenery with the rich pine and other forests

and the numerous feeding-grounds or *Alps*, from which the chain has received its name.

The higher Alps, which form the western division, commence on the Gulf of Genoa and curve round, first by the west, and then to the north, as far as Mont Blanc. Turning to the east and north, they run through Switzerland and the Tyrol, terminating in the Great Glockner (12,956 feet). The length of this line is upwards of four hundred miles. All of it is lofty, and much of it far above the line of perpetual congelation, which in the Alpine system generally may be said to rise to the height of 9000 feet. To the east of the Great Glockner the Alps split into two branches, called respectively the Noric and the Carnic Alps. The latter is the principal group. Passing into the Julian Alps it joins the Balkan. It separates the Tyrol and Upper Carinthia from the Venetian States, and is much lower than the western mountains.

The width of the Alpine chain in the highest part is about one hundred miles. Further to the east it is wider, gradually increasing to two hundred miles, and then again narrowing to the point where it connects with the Balkan. At this point the elevated land is not more than eighty miles in width.

There are few lakes or pools among the Alps themselves, although both to the north and south of the chain, in Switzerland and Northern Italy, the lakes are among the most striking characteristics of the scenery. There are also no table-lands or plateaux near the higher summits. The higher mountains seem to be to some extent detached, but whether this be due to there being many centres of elevation, or whether it is the result of denudation and natural weathering, acting in a somewhat unusual and extreme manner, we must not here discuss. It is certain that the Alpine chain consists of numerous mountain masses, often with very little apparent connection geologically; but that these have a certain and intimate relation, and have been elevated by contemporaneous upheavals, there cannot be a doubt. At the same time denudation has played a very important part in all the phenomena of Switzerland and the Tyrol, and there is not a

mountain peak, a ravine, or an exposed surface of rock, that does not speak of this in language not to be misunderstood.—ANSTED'S *Physical Geography*.

THE SAHARA.

THE Sahara may be likened to a vast ocean separating the negro kingdoms of equatorial Africa from the more civilized states of the north; and the oases (fertile spots) with which it is studded are like so many islands, or archipelagoes of islands, in the midst of the desert waste. This waste, however, though destitute of everything helpful to human life and comfort, does not always consist of barren sands. There is a vast extent of dry, stunted herbage, on which the camel can pasture; and thus a passage across the desert is rendered practicable by routes which would be hermetically sealed were the Sahara—what it is often represented as being—one wide sandy plain.

In the desert a route through the sand is always chosen in preference to any other; because in the sandy tracts the springs are most likely to be found, and because the sand presents a soft dry bed on which the traveller can repose after the fatigues of the day. It is this preference of the natives which has led Europeans to suppose that the whole of the Sahara is a sandy waste. The character of the desert is very much the reverse of this, there being hundreds of miles of hard, firm soil, and hundreds more a mixture of stony fragments and pebbles.

Travelling on sand, there is of course no visible road, as the fierce winds that frequently recur soon obliterate all trace of footsteps. The guides, therefore, find their way by landmarks, which they carefully renew when necessary. These are often the most trifling objects, such as a tuft of herbage, a single plant, or the summit of a swell in the soil. In places where the plain is one void and arid flat, even such objects are wanting, and their place is supplied by heaps of stones or cairns piled at great distances. Sometimes the route will extend for ten or twelve days over a plain affording not a single drop of moisture.

OASES.

Along nearly the whole length of the northern shores of the continent there extends a fertile belt of land, called by the natives the Tell, the cultivation of which yields the means of life to the populations of the coast. In the neighbourhood of this fertile belt there are numerous oases extending into the interior; while others, fortunately for the purposes of commerce and civilization, exist within practicable distances across the whole desert. Further eastward, near the limits of the Sahara, a line of oases extends from its northern to its southern boundary. Of these, the Great Oasis of Thebes is a hundred and twenty miles in length.

The oases invariably lie in the lowest levels of the soil, and doubtless owe their existence to the moisture which naturally gravitates towards such localities. Most of these isolated spots, even though hundreds of miles apart, enjoy a constant supply of water, and are favourable to the cultivation of the date-palm and other fruit-trees, as well as of various kinds of vegetables.

The date-palm (*Phœnix dactylifera*) supplies a large proportion of the food of the desert tribes. The tree is thirty years in coming to maturity, after which it will bear fruit for seventy years more, the annual crop of each tree weighing from three to four hundred pounds. Not only man, but all the animals of the desert can feed on the date. The fruit is easily preserved by packing it closely in woollen bags; and when thus compressed into solid masses, it will keep for several years. Sometimes a tree is tapped for the sake of its sap, which is much relished as a beverage, and when allowed to ferment forms a drink resembling cider. A single tree will yield fourteen or fifteen quarts a day for two years, but will die if the drain be continued longer. Every part of the date-palm (like the cocoa, palmyra, and other palms) is turned to profitable account. The wood is used for building and every species of carpenter-work; the fibre is twisted into ropes; baskets are made of the branches; and sheep are fattened with the pounded stones of the fruit.

TRIBES OF THE DESERT.

The population of the desert is necessarily sparse and scanty in comparison with its enormous area. It consists of various tribes of two distinct nations—the Berbers, made up of descendants of the ancient Libyans, the Romans, and the Vandals; and the Arabs, originally invaders, and who yet retain, in no small degree, their original characteristics.

The Berbers are the settled inhabitants of the oases, where the men cultivate the ground, and the women manage the manufactures. They maintain amicable relations with their nomadic brethren, to whom they are in the habit of confiding the care of such cattle as they possess, and of whose property they undertake the custody during the wanderings of the owners. The oasis generally contains a village (Ksar), built of stone, and, together with the gardens, walled in. Nothing is grown but what will produce food of some kind or other, and the utmost use is made of every foot of land and drop of water. At the same time provision is made for defence, and sentinels are kept continually on the watch for an enemy. Outside the walls are the marabets, or sepulchres of the dead, upon which are lavished far more expense and taste than on the abodes of the living. Near each tomb rises a little sepulchral chapel, executed in a finished style of architecture by the most skilful artisans that can be procured. These buildings are universally held sacred; and even the foe who would slaughter the living and make a prey of their property, will leave the resting-places of the dead inviolate.

The life of the desert nomads, even when free from war and brigandage, is one of perpetual variety and excitement. They spend the winter and spring in the wilderness, where, at these seasons, there is both water and pasture; but they remain in one spot only for a few days, striking their tents and migrating to another as soon as the pasture is consumed. As summer approaches they resort to the oases where their property is kept; here they load their camels with merchandise, and journey northward. They arrive in the Tell just at harvest-time, when the

price of corn is low: the land being reaped, their flocks and herds are allowed to browse on it freely, and manure it by their droppings. Here the inhabitants of the desert pass the summer in bartering and commerce, exchanging their woollen goods and dates for raw wool, sheep, &c. At the close of the summer they are again off southward, arriving at the oases in October, just as the dates are ripe. Their assistance is now valuable in gathering in the crops, at which they occupy themselves for a month, and another month is spent in bartering their raw wool and other late purchases for a portion of the dates which they have helped to gather, and the manufactured garments made by the women. These they deposit in their magazines, and then withdraw again to the desert, with their flocks and herds, until the return of summer calls them back to the oases.

CARAVANS.

There are two classes of caravans, either of which a traveller may join if he choose. The first, and most expeditious, is the *gafala*, or merchants' caravans, which start with some degree of regularity from certain depôts in the northern oases, and whose departures are always made known beforehand. The camel-drivers regulate the speed of the journey, generally travelling from twenty to twenty-five miles a day, save in regions infested by robbers, where they will occasionally double that rate of speed. In case of attack, every one defends himself and his property as he best can, and the timid are seen rushing towards the centre to escape being cut off as stragglers.

The second species of caravan is the *neja*, which consists of a whole tribe in migration, and which travels much more slowly. The migrants carry with them, not their merchandise merely, but all their cattle, tents, and household stuff, together with their women, children, domestic animals, and poultry. They jog along at an easy rate, and the journey is pleasant enough so long as no enemy appears; but should they meet the bands of a hostile tribe while thus encumbered, it may chance to go hard with them. The battle which ensues is one in which quarter is

neither asked nor given—the Arabs being much more bitter in their warfare against each other than in their encounters with Europeans. Sunset is the signal for the cessation of the strife, and the defeated party is allowed to make off in the night. In these conflicts prisoners are never made, the conquerors preferring the heads of their victims to any ransom that could be offered.

From Morocco six caravans traverse the Sahara every year, when from two to three thousand camels are loaded with European produce, and start for the distant countries of the interior. Some of these caravans penetrate as far into Soudan as Timbuctu, Kanou, and Noufi. They bring thence gold dust, gooroo nuts, buffalo skins, ivory, senna, alkali, rhinoceros horns, indigo, diamonds, perfumes, gums, &c., &c. On reaching the banks of the Niger, the Moors deposit their merchandise on a hill; they then retire, and the negroes advance and criticise the goods: after an examination of three days they generally come to terms, and the business is done.

ARABS OF THE NUBIAN DESERT.

The Arabs generally adhere strictly to their ancient customs, independently of the comparatively recent laws established by Mahomet. They attach great importance to the laws of Moses, and to the customs of their forefathers; neither can they understand the reason for a change of habit in any respect where necessity has not suggested the reform. The Arabs are creatures of necessity; their nomadic life is compulsory, as the existence of their flocks and herds depends upon the pasturage. Thus, with the change of seasons they must change their localities, according to the presence of fodder for their cattle. Driven to and fro by the accidents of climate, the Arab has been compelled to become a wanderer; and precisely as the wild beasts of the country are driven from place to place, either by the arrival of the fly, by the lack of pasturage, or by the want of water, even so must the flocks of the Arab obey the law of necessity, in a

country where the burning sun and total absence of rain for nine months of the year convert the green pastures into a sandy desert. The Arabs and their herds must follow the example of the wild beasts, and live as wild and wandering a life. In the absence of a fixed home, without a city, or even a village that is permanent, there can be no change of customs. There is no stimulus to competition in the style of architecture that is to endure only for a few months; no municipal laws suggest deficiencies that originate improvements. The Arab cannot halt in one spot longer than the pasturage will support his flocks; therefore his necessity is food for his beasts. The object of his life being fodder, he must wander in search of the ever-changing supply. His wants must be few, as the constant changes of encampment necessitate the transport of all his household goods; thus he reduces to a minimum the domestic furniture and utensils. No desires for strange and fresh objects excite his mind to improvement, or alter his original habits; he must limit his *impedimenta* (baggage or encumbrances), not increase them. Thus, with a few necessary articles he is contented. Mats for his tent; ropes manufactured from the hair of his goats and camels; pots for carrying fat; water-jars; earthenware pots or gourd shells for containing milk; leather water-skins for the desert; and sheep-skin bags for his clothes;—these are the requirements of the Arabs. Their patterns have never changed; the water-jar of to-day is of the same form as those carried to the well by the women of thousands of years ago.

The conversation of the Arabs is in the exact style of the Old Testament. The name of God is coupled with every trifling incident in life; and they believe in the continual action of divine special interference. Should a famine afflict the country, it is expressed in the stern language of the Bible: "The Lord has sent a grievous famine upon the land;" or, "The Lord called for a famine, and it came upon the land." Should their cattle fall sick, it is considered to be an affliction by divine command; or should the flocks prosper and multiply particularly during one season, the prosperity is attributed to special interference.

Nothing can happen in the usual routine of daily life without a direct connection with the hand of God, according to the Arab's belief. This striking similarity to the descriptions of the Old Testament is exceedingly interesting to a traveller when residing among these curious and original people. With the Bible in one's hand, and these unchanged tribes before the eyes, there is a thrilling illustration of the sacred record; the past becomes the present; the veil of three thousand years is raised, and the living picture is a witness to the exactness of the historical description.

There is a fascination in the unchangeable features of the Nile regions. There are the vast Pyramids, that have defied Time; the river upon which Moses was cradled in infancy; the same sandy deserts through which he led his people; and the watering-places, where the flocks were led to drink. The wild and wandering tribes of Arabs, who thousands of years ago dug out the wells in the wilderness, are represented by their descendants unchanged, who now draw water from the deep wells of their forefathers with the skins that have never altered their fashion. The Arabs, gathering with their goats and sheep around the wells to-day, recall the recollection of that distant time when "Jacob went on his journey, and came into the land of the people of the East. And he looked, and behold a well in the field, and, lo, there were three flocks of sheep lying by it; for out of that well they watered the flocks: and a great stone was upon the well's mouth. And thither were all the flocks gathered: and they rolled the stone from the well's mouth, and watered the sheep, and put the stone again upon the well's mouth in his place." The picture of that scene is an illustration of Arab daily life in the Nubian deserts, where the present is the mirror of the past.—*Abridged from* BAKER's *Nile Tributaries of Abyssinia.*

THE GREAT DISMAL SWAMP.

THERE are many swamps or morasses in this low, flat region; and one of the largest of these occurs between the towns of Nor-

folk in Virginia and Welden in North Carolina. We traversed several miles of its northern extremity on the railway, which is supported on piles. It bears the appropriate and very expressive name of the "Great Dismal," and is no less than forty miles in length from north to south, and twenty-five miles in its greatest breadth from east to west—the northern half being situated in Virginia, the southern in North Carolina. I observed that the water was obviously in motion in several places, and the morass has somewhat the appearance of a broad inundated river-plain, covered with all kinds of aquatic trees and shrubs, the soil being as black as that of a peat-bog. It is one enormous quagmire, soft and muddy, except where the surface is rendered partially firm by a covering of vegetables and their matted roots; yet, strange to say, instead of being lower than the level of the surrounding country, it is actually higher than nearly all the firm and dry land which encompasses it; and to make the anomaly complete, in spite of its semi-fluid character it is higher in the interior than towards the margin!

The only exception to both these statements is found on the western side, where, for the distance of about twelve or fifteen miles, the streams flow from slightly elevated but higher land, and supply all its abundant and overflowing water. Towards the north, the east, and the south, the waters flow from the swamp to different rivers, that give abundant evidence, by the rate of their descent, that the Great Dismal is higher than the surrounding firm ground. This fact is also confirmed by the measurements made in levelling for the railway from Portsmouth to Suffolk, and for two canals cut through different parts of the morass for the sake of obtaining timber. The railway itself when traversing the Great Dismal is literally higher than when on the land some miles distant on either side, and is six or seven feet higher than where it passes over dry ground, near to Suffolk and Portsmouth. Upon the whole, the centre of the morass seems to lie more than twelve feet above the flat country around it. If the streams which now flow in from the west had for ages been bringing down black fluid mire, instead of water, over the

firm subsoil, we might suppose the ground so inundated to have acquired its present configuration. Some small ridges of land, however, must have existed in the original plain or basin, for these now rise like low islands in various places above the general surface. But the streams to the west do not bring down liquid mire, and are not charged with any sediment. The soil of the swamp is formed of vegetable matter, usually without any admixture of earthy particles. We have here, in fact, a deposit of peat from ten to fifteen feet in thickness, in a latitude where, owing to the heat of the sun and length of the summer, no peat-mosses like those of Europe would be looked for under ordinary circumstances.

In countries like Scotland and Ireland, where the climate is damp, and the summer short and cool, the natural vegetation of one year does not rot away during the next, in moist situations. If water flows into such land, it is absorbed, and promotes the vigorous growth of mosses and other aquatic plants; and when they die, the same water arrests their putrefaction. But, as a general rule, no such accumulation of peat can take place in a country like Virginia, where the summer's heat causes annually a quantity of dead plants to decay, equal in amount to the vegetable matter produced in any one year. There are, however, many trees and shrubs in the region of the Pine Barrens which, like our willows, flourish luxuriantly in water. The juniper tree and white cedar (*Cupressus thyoides*) stand firmly in the softest part of the quagmire, supported by their long top-roots, and afford, with many other evergreens, a dark shade, under which a multitude of ferns, reeds, and shrubs, from nine to eighteen feet high, spring up and are protected from the rays of the sun. When these are most powerful, the large cedar (*Cupressus disticha*) and many other deciduous trees are in full leaf. The black soil formed beneath this shade, to which the mosses and the leaves make annual additions, does not perfectly resemble the peat of Europe, most of the plants being so decayed that they leave little more than black mud, without any traces of organization. The loose soil is called "sponge" by the labourers;

and it has been ascertained that when exposed to the sun, and thrown out on the bank of a canal, where clearings have been made, it rots entirely away. Hence it is evident that it owes its preservation in the swamp to moisture and the shade of the dense foliage. The evaporation continually going on in the wet spongy soil during summer cools the air, and generates a temperature resembling that of a more northerly climate, or a region more elevated above the level of the sea.

Numerous trunks of large and tall trees lie buried in the black mire of the morass. In so loose a soil they are easily overthrown by winds; and nearly as many have been found lying beneath the surface of the peaty soil as standing erect upon it. When thrown down, they are soon covered by water; and being kept wet, they never decompose, except the sap-wood, which is less than an inch thick. Much of the timber is obtained by sounding a foot or two beneath the surface, and it is sawn into planks while half under water.

The Great Dismal has been described as being highest towards the centre. Here, however, there is an extensive lake of an oval form, seven miles long and more than five wide; the depth, where greatest, fifteen feet; and its bottom consisting of mud like the swamp, but sometimes with a pure white sand, a foot deep, covering the mud. The water is transparent, though tinged of a pale brown colour, like that of our peat-mosses, and contains abundance of fish. Much timber has been cut down, and carried from the swamp by means of canals, which are perfectly straight for long distances, with the trees on each side arching over and almost joining their branches across, so that they throw a dark shade on the water, which of itself looks black, being coloured as before mentioned. When the boats emerge from the gloom of these avenues into the lake, the transformation is said to be as beautiful as fairy-land.—Sir Charles Lyell—*Travels in North America.*

THE TUNGUSIANS OF THE UPPER AMOOR.

THESE Tungusians lead a wandering life. During spring and the beginning of summer they generally reside on the banks of the river, engaged in fishing; but in the autumn and winter they retire to the interior of the country to pursue the chase. In these migrations the reindeer or the horse carries the scanty property of its owner. The only other domestic animal is the dog. We need not be surprised, considering this mode of life, if their habitations do not bear the stamp of permanency. They are, in fact, conical yurts or tents, easily built and more easily removed. Some twenty poles are stuck into the ground to form a circle of from ten to fourteen feet in diameter, and they are tied together about ten feet above the centre of the circle. This frame is covered with birch-bark, and above that with the skins of the reindeer and moose. An opening is left in front to serve as a door, and a hole in the top for a chimney. During winter the door is closed by furs or skins. In case of a temporary removal, the bark and the skins are taken away, but the poles are left standing.

A hole in the centre of the tent serves as a fire-place; and above it the most important household utensil, a shallow iron pot with two handles, is suspended from a tripod of wooden staves. The floor is covered with felt carpets, manufactured from the hair of the reindeer or moose. Low wooden benches on the sides serve as beds, and are covered with furs. The seat of honour is opposite the entrance. It is reserved for guests, and must never be occupied by the women. On entering, the guest sits down there; the host offers him a pipe, which is then passed round the circle until it is smoked out, when gruel with small pieces of meat in it is served up in birch-bark cups.

In front of the yurts are scaffoldings for drying fish and meat; and at a greater distance are storehouses placed upon poles, beyond the reach of animals, where all those things are kept which are not taken upon the migrations. These storehouses

are religiously respected, and are never known to have been plundered. The fisheries during spring and summer prove very productive. Sturgeons, taimen, bielugas, and kelugas of a very large size, the caviâre (preserved roe) of which often weighs thirty-six pounds and more, are taken by means of harpoons or of snares. The fish caught are either reserved for their own use or exchanged with the Cossacks for rye-flour.

The ordinary dress of the men consists of short and wide leather drawers girthed round the waist, and a kind of frock made of fur or leather, reaching down to the knees. The frock is confined by a belt of leather or horse-hair, attached to which they carry a great many things of daily use, such as a knife, a tobacco-pouch, flint and steel, a pipe, an iron tobacco-stoker, ear-picks, a small pair of tweezers for pulling out the beard, a purse, and so forth. The head-dress is a structure of several semi-circular caps of fur or leather; and the feet are generally encased in boots of reindeer leather, with the hair inside, and the outside embroidered. The dress of the women does not materially differ from that of the men. The frock and gown are, however, longer, and trimmed with stripes of coloured cloth. In a girdle or belt they generally carry every requisite for smoking—for women and children are equally addicted to this habit! There is, besides, attached to the belt a sort of housewife, with needles and thread, —proofs of their domestic virtues. The head-dress is either a piece of cloth, or a structure resembling that of the men, but many-coloured, and decorated with ribbons hanging down the back.

Among the Tungusians the women hold a very inferior position. Not only is the whole of the domestic labour assigned to them, but they have to build and take down the yurts, load and unload the reindeer, prepare the hides, manufacture cloth and birch-bark matting, and in general perform all the drudgery of the encampment.—Ravenstein—*The Russians on the Amoor.*

VALLEYS—THEIR NATURE AND ORIGIN.

VALLEYS are by no means to be regarded as necessarily in contradistinction to hills. Geographically, they represent depressions occupied partly by streams that run through them; but they are often of extreme width compared with the rivers from which they receive their names. In mountain districts they are enclosed by lofty walls; but across great continents, away from the mountains, they are bounded only by hypothetical and assumed limits. There are thus narrow and shut-in valleys, generally at a high level above the sea; and open valleys, scarcely different, except in name, from low plains.

The upper valleys in mountain districts are often remarkable for their scenery. Receiving the snow from the mountains, they afford the shelter in which glaciers accumulate. They are occasionally blocked up by some natural obstacle, and form the beds of lakes. They fall rapidly, and the rivers rushing down them, leap from rock to rock in cascades and waterfalls. Their sides, grooved and scratched by ice, or smoothed and worn by the constant erosive action of water, exhibit more clearly and completely than any other parts of the Earth's surface the nature of the forces that have acted to produce its existing physical features. They are thus landmarks and indications of progress as well as of destruction.

Geologically, there are valleys of fracture, or fault, and valleys of erosion. All rocks, in being lifted to form mountain masses, must be cracked and broken, and in many cases one side is lifted higher than the other. Thus are formed mountain-gorges, some of which are of the grandest character. Very soon these crevices, or fissures, are acted on by running water; their walls are undermined and broken down; the rain, forming a stream or increasing a stream already in existence, rushes down, pounding and carrying away a large portion of the fractured walls, and leaving some part as a rocky bottom. In this way are produced those varieties of form which astonish and delight the traveller,

and speak with such distinct voice to the student of Nature, teaching him the true origin of appearances which he might at first regard as proofs of convulsive action, or of disruptions inconceivably greater than could be caused by any force now recognized. All valleys are more or less distinctly valleys of erosion. Many are nothing more than this, and are the result of the daily and ceaseless grinding power of running water, increased greatly in effect by atmospheric change. In some countries the very beginning of the formation of a valley in a plain may be seen, and its rate calculated; but more usually the work is noticed only when it has already been so long in course of proceeding that the actual spot where the valley originally commenced cannot be detected.

The lower valleys, or continuations of the upper and more technical and typical valleys, are illustrated in England by the valleys of the Thames and Severn, as they open out to the sea. The valley of the Rhine, sometimes open and wide, sometimes shut in by approaching mountains, is a better example. The valley of the Danube is on a still nobler scale, especially where it spreads out in the plains of Wallachia, after being shut in at the Iron Gate, where the Carpathians are crossed. But it is chiefly in the countries where the largest rivers exist that the phenomena of great valleys must be studied. The valleys of the Ganges in India, of the Mississippi in North America, and of the Amazons in South America, are of this kind. They are vast spaces of comparatively low and level ground, and thus pass into and are lost in the gigantic low plains, which are regarded as a somewhat different condition of the surface. There are other vast spaces hollowed out also by water, but with no natural outlet to the sea; and these, too, must be regarded as valleys, though of a somewhat different kind. The valleys of the great rivers of Southern Africa are of this kind, and perhaps some of those of Australia.

Valleys have been described as the great natural highways of the world, and in a very important sense they are so. When traversed by navigable rivers, they facilitate progress, and the

earliest civilization of the world was probably governed and guided by these physical conditions. Greece and Rome, however, owe nothing to great valleys; although India, China, and Egypt may be quoted as examples in favour of this view. In modern times, human interests are so closely connected with easy communication, that valleys would seem to have once more taken their place among the necessities of success in new colonies, were it not that Australia is of all countries that which has the fewest of these advantages.—*Abridged from* Ansted's *Geography.*

THE SEAS OF EUROPE—THEIR LIFE-PROVINCES.

The sea-board of Europe, exclusive of Iceland, extends through four degrees of latitude and six of longitude, occupying three sides of an irregular quadroid. The northern and narrowest side lies within the Arctic Circle, is partly included in the Icy Sea, and presents a deeply-serrated outline, indented in its centre by the great arm or gulf known as the White Sea. The western side exhibits all varieties of conformation. In its most northern and Norwegian portion it is belted with small islands, and indented with fiords. At the southern termination of Norway we have the tortuous gulfs conducting to the Baltic Sea. The coasts of Denmark and Holland form a tame boundary to the shallow portion of the North Sea, itself originating in the projection northwards of the group of islands of which Great Britain and Ireland are the chief. The deep bend of the Bay of Biscay carries us southward, with a simple outline, to the junction of France and Spain, and to the rocky and partially jagged coasts of Asturias, from whence to the end of Europe, at the Pillars of Hercules, a tame and but slightly-varied line prevails. The southern side is of great extent and variety, forming as it does the wavy and irregular margin of the Mediterranean, with its deep arms of the Adriatic and Ægean, and continued to make the tamer bounds of the Euxine. A last and isolated portion is

that which terminates Europe on the south-east, and constitutes the north-western border of the Caspian Sea.

Along such a range of shore, extending through various climates, from the warm and sunny confines of Africa to the ice-bound cliffs of Nova Zembla and Spitzbergen, we cannot fail to find many and diversified assemblages of animated creatures. The beings that delight in the chilly waters of the Arctic Ocean must be very different from those that revel in the genial seas of the South; whilst the temperate tides which lave our own favoured shores cherish a submarine population intermediate in character between both. Thus, in our progress from north to south, we pass through regions or belts exhibiting successive changes in the features of animated nature. It is not so, however, in proceeding from the Straits of Gibraltar to the easternmost recesses of the Mediterranean; for, passing along the same parallel of latitude throughout, we carry with us, as it were, the creatures that met with us at the gates; and when we enter the less pleasant expanse of the Black Sea, we find the difference marked by deficiencies rather than by the presence of new creatures. In the inland and isolated Caspian, it is true, we behold strange and peculiar animals; but their presence is rather to be regarded in connection with the past than with the present—as the living witnesses of pre-Adamic ages than as members of the community of creatures characteristic of the epoch in which we live.

This extensive range of seas I propose to regard as comprehending six provinces. The first and northernmost is the *Arctic*, extending throughout that portion of the European seas included within the Arctic Circle. The second is the *Boreal*, including the seas which wash the shores of Norway, Iceland, the Faroe and the Zetland Isles. The third is the *Celtic*, in which rank the British Seas, the Baltic, and the shores of the Continent from Bohnslau to the Bay of Biscay. The *Lusitanian* province includes the Atlantic coasts of the Peninsula. The *Mediterranean* speaks its own explanation; the Black Sea is included in it. Lastly, the *Caspian* is a region now completely isolated from all the others.—EDWARD FORBES—*Natural History of the European Seas.*

THE NILE INUNDATION.

The most remarkable feature in the Nile is the regularity of its annual inundation, which, so far as geographers have evidence, has remained unchanged for the last four thousand years. The cause of this phenomenon is thus explained by Sir Samuel Baker, in his recent work on *The Nile Tributaries of Abyssinia* :—" It has been determined, by the joint exploration of Speke, Grant, and myself, that the rain-fall of the equatorial districts supplies two vast lakes—the Victoria and the Albert—of sufficient volume to support the Nile throughout its entire course of thirty degrees of latitude, or, more minutely, of two thousand three hundred miles. Thus the parent stream, fed by never-failing reservoirs, supplied by ten months' rain-fall of the equator, rolls steadily on its way through arid sands and burning deserts, until it reaches the Delta of Lower Egypt.

" It would at first sight appear that the discovery of the lake-sources of the Nile had completely solved the mystery of ages, and that the fertility of Egypt depended upon the rain-fall of the equator concentrated in the lakes Victoria and Albert ; but the exploration of the Nile tributaries of Abyssinia divides the Nile system into two portions, and unravels the entire mystery of the river, by assigning to each its due share in ministering to the prosperity of Egypt. The lake sources of Central Africa support the *Life* of Egypt, by supplying a stream, throughout all seasons, that has sufficient volume to support the exhaustion of evaporation and absorption ; but this stream, if unaided, could never overflow its banks, and Egypt, thus deprived of the annual inundation, would simply exist, and cultivation would be confined to the close vicinity of the river.

" The inundation, which by its annual deposit of mud has actually created the Delta of Lower Egypt, and upon whose overflow the fertility of Egypt depends, has an origin entirely separate from the lake-sources of Central Africa, and the supply of water is derived exclusively from Abyssinia. The two grand

affluents of Abyssinia are the Blue Nile and the Atbara, which join the main stream respectively in north latitude 15° 30′ and 17° 37′. These rivers, although streams of extreme grandeur during the period of the Abyssinian rains, from the middle of June till September, are reduced during the dry months to utter insignificance; the Blue Nile becoming so shallow as to be unnavigable, and the Atbara perfectly dry. At that time, the water supply of Abyssinia having ceased, Egypt depends solely on the equatorial lakes and the affluents of the White Nile, until the rainy season shall again have flooded the two great Abyssinian arteries. That flood occurs suddenly, about the 20th of June, and the grand rush of water pouring down the Blue Nile and the Atbara into the parent channel inundates Lower Egypt, and is the cause of its extreme fertility.

"Not only is the inundation the effect of the Abyssinian rains, but the deposit of mud that has formed the Delta, and which is annually precipitated by the rising waters, is also due to the Abyssinian streams, more especially to the river Atbara, which, known as the Bahr al Aswat (Black River), carries a larger proportion of soil than any other tributary of the Nile; therefore to the Atbara, above all other rivers, must the wealth and fertility of Egypt be attributed. It may be thus stated:—The equatorial lakes *feed* Egypt, but the Abyssinian rivers *cause the inundation.*"

This remarkable inundation, whatever be its beginning in the upper branches of the river, is not perceptible at Cairo till towards the summer solstice. It then continues to rise for nearly a hundred days, and remains at its greatest height till the middle of October, when it begins to subside, and reaches its lowest point in April and May. In Upper Egypt, the height of the flood is from 30 to 35 feet; at Cairo, from 20 to 24; and in the northern part of the Delta, where it spreads out over a wider area, it seldom exceeds 4 or 5 feet. The fine black slime or mud deposited by this inundation has been, through all history, the unfailing source of wealth and fertility to Egypt, and from its accumulation, in like manner, has arisen the formation and increase of the Delta.

THE SARGASSO SEA OF THE ATLANTIC.

WHILE we were in about the 56th degree of west longitude, and between the 22nd and 28th of north latitude, we passed through those enormous fields of floating sea-weed (*Sargassum bacciferum*) which have been described by almost every voyager in those seas. It appeared generally in long narrow strips or bands, lying across the wind, sometimes not more than the ship's length apart, and at other times at a considerable distance from each other. Much diversity of opinion exists as to the origin of this floating mass. Humboldt believes it to be detached from rocks at a considerable depth in the latitudes where it floats; while others suppose it to come from the shores of the northern seas, having been detached from the rocks by the violence of the waves. Some, again, imagine that it comes from the rocky shores of the gulfs of Mexico and Florida; while many agree with me in believing that it has never had any other than its present place of abode, no one having ever seen it attached to rocks, or discovered roots belonging to it. During the five or six days that we sailed through the gulf-weed I hooked on board more than a thousand pieces, and every one of them presented the same appearance: the lower end of the stem had always a whitish, decayed appearance, just like a piece of tangle which has been some time cast on shore, while the extremities of the branches were universally of a very fresh and healthy appearance. Such being the case, we can scarcely help believing that these remarkable plants have existed since the time of their creation to the present period as we now find them, floating always in this revolving Gulf Stream, and undergoing a perpetual mutation from decay at the one extremity and growth at the other. There is nothing unreasonable in this opinion, as sea-weeds are not like land plants, which derive nourishment from the spot to which they are attached. I found among the weed a great variety of zoophytes and other minute marine animals. A crab measuring from an inch to an inch and a half across was frequent; and I observed the nest of one, formed

by the small branches woven together by a kind of thread, and containing a number of young ones.—GARDNER'S *Travels in Brazil.*

THE BLACK STREAM OF THE PACIFIC.

THIS ocean-current, known to the Japanese as the Kuro-Siwo or Black Stream, from its dark colour as compared with that of the adjacent ocean, corresponds in a wonderful manner, both in its character and effects, with the Gulf Stream of the Atlantic. As the latter carries heat and moisture across the North Atlantic, and warms the western sea-board of Europe, so the former conveys heat and moisture across the North Pacific, and warms and fertilizes the islands of Japan. Its rise, course, and character have been described as follows by Lieutenant Bent of the United States Navy, in a paper read before the Geographical and Statistical Society of New York:—"The fountain from which this stream springs is the great Equatorial Current of the Pacific, which in magnitude is in proportion to the vast extent of that ocean when compared with the Atlantic. Extending from the tropic of Cancer, on the north, to Capricorn, in all probability, on the south, it has a width of nearly three thousand miles. With a velocity of from twenty to sixty miles per day, it sweeps to the westward in uninterrupted grandeur around three-eighths of the circumference of the globe, until, diverted by the continent of Asia, and split into innumerable streams by the Polynesian Islands, it spreads the genial influence of its warmth over regions of the Earth, some of which, now teeming in prolific abundance, would otherwise be but barren wastes.

"One of the most remarkable of these offshoots is the Kuro-Siwo, or Japan Stream, which, separated from the parent country by the Bashee Islands and south end of Formosa, in lat. 22° north, long. 122 east, is deflected to the northward along the east coast of Formosa, where its strength and character are as decidedly marked as those of the Gulf Stream on the coast of Florida. This northwardly course continues to the parallel of 26° north, when

it bears off to the northward and eastward, washing the whole south-east coast of Japan as far as the Straits of Sangar, and increasing in strength as it advances, until reaching the chain of islands to the southward of the Gulf of Yedo, where its maximum velocity is eighty miles per day. Its average strength from the south end of Formosa to the Straits of Sangar is found to be from thirty-five to forty miles per twenty-four hours at all seasons that we traversed it.

"Near its origin, the Kuro-Siwo, like the Gulf Stream, is contracted, and is usually confined between Formosa and the Majico-Sima Islands, with a width of 100 miles. But to the northward of this group it rapidly expands on its southern limit, and reaches the Lew-Chew and Bonin Islands, giving it a width to the northward of the latter of about 500 miles. To the eastward of the meridian of 143° east, in latitude 40° north, the stream takes a more easterly direction, allowing a cold current to intervene between it and the southern coast of Yesse, where the thermal change in the water is from 16° to 20°; but, from the harassing prevalence of fogs during our limited stay in that vicinity, it was impossible to make such observations or experiments as to prove conclusively the predominant direction of this cold current through the Straits of Sangar, particularly as the tide ebbs and flows through them with great rapidity. Yet, from what we have, I am inclined to believe that it is a current from the Arctic Ocean running counter to the Kuro-Siwo, and which passes to the westward through the Straits of Sangar, down through the Japan Sea, between Corea and the Japanese Islands, and feeds the hyperborean current on the east coast of China, which flows to the southward through the Formosa Channel into the China Sea. For to the westward of a line connecting the north end of Formosa and the south-western extremity of Japan there is no flow of tropical waters to the northward, but, on the contrary, a cold counter-current filling the space between the Kuro-Siwo and the coast of China, as is distinctly shown by our observations. As far as this cold water extends off the coast, the soundings are regular, and increase gradually in depth; but simultaneously with

the increase of temperature in the water the plummet falls into a trough similar to the bed of the Gulf Stream, as ascertained by the United States Coast Survey.

"The influence of the Kuro-Siwo upon the climate of Japan and the west coast of North America is, as might be expected, as striking as that of the Gulf Stream on the coasts bordering the North Atlantic. From the insular position of Japan, with the intervening sea between it and the continent of Asia, it has a more equable climate than we enjoy in the United States; and since the counter-current of the Kuro-Siwo does not make its appearance on the eastern shores of the islands, south of the Straits of Sangar, and as these islands, in their geographical position, have a more eastwardly direction than our coast, the Kuro-Siwo, unlike the Gulf Stream, sweeps close along this shore, giving a milder climate to that portion of the empire than is enjoyed in corresponding latitudes in the United States.

"The softening influence of the Kuro-Siwo is felt on the coasts of Oregon and California, but in a less degree, perhaps, than that of the Gulf Stream on the coasts of Europe, owing to the greater width of the Pacific Ocean over the Atlantic. Still, the winters are so mild in Puget's Sound, in latitude 48° north, that snow rarely falls there, and the inhabitants are never enabled to fill their ice-houses for the summer; and vessels trading to Petropaulowski and the coast of Kamtskatka, when becoming unwieldy from accumulation of ice on their hulls and rigging, run over to a higher latitude on the American coast and thaw out, in the same manner that vessels frozen up on our own coast, retreat again into the Gulf Stream, until favoured by an easterly wind."

THE TIDAL BORE OF THE TSIEN-TANG.

In the open expanse of the Southern Ocean, as well as over a large portion of the Pacific, the tidal wave rarely exceeds five or six feet in height, and in the Indian and Atlantic Oceans perhaps eight or ten; but in bays and gulfs opening broadly to its course

and narrowing towards their interior recesses, such as the Bay of Bengal, our own Bristol Channel, and the American Bay of Fundy, it may rise to 20, 30, or, under favourable circumstances of wind and season, even to 50 or 60 feet in height. And where such seas terminate in river-estuaries, the wave, still converging, forms a high head or wall of water, termed a *Bore* or *Ægre*, which ascends the river with sudden and destructive impetuosity. Tidal bores of considerable magnitude occur in many rivers, such as the Severn, Garonne, Amazon, Hooghly, Sakerang in Borneo, &c.; but that of the Tsien-tang in China appears to excel them all in grandeur, especially at spring-tides and during strong easterly gales. Dr. Macgowan, who witnessed it during a visit to Hang-chow-foo, gives the following graphic account in the *Transactions of the Royal Asiatic Society*:—"Between the river and the city walls, which are a mile distant, dense suburbs extend for several miles along the banks. As the hour of flood-tide approached, crowds gathered in the streets running at right angles with the Tsien-tang, but at safe distances. My position was a terrace in front of the *Tri-wave* temple, which afforded a good view of the entire scene. On a sudden all traffic in the thronged mart was suspended; porters cleared the front street of every description of merchandise, boatmen ceased lading and unlading their vessels, and put out into the middle of the stream, so that a few minutes sufficed to give a deserted appearance to the busiest part of one of the busiest cities in Asia. The centre of the river teemed with craft, from small boats to large barges, including the gay 'flower-boats.' Loud shouting from the fleet announced the appearance of the flood, which seemed like a glistening white cable stretched athwart the river at its mouth, far down as the eye could reach. Its noise, compared by Chinese poets to that of thunder, speedily drowned that of the boatmen; and as it advanced with prodigious velocity—at the rate, I should judge, of twenty-five miles an hour—it assumed the appearance of an alabaster wall, or rather of a cataract four or five miles across, and about thirty feet high, moving bodily onward. Soon it reached the advanced guard of the immense assemblage of

vessels awaiting its approach. Knowing that the Bore of the Hooghly—which scarcely deserves mention in connection with the one before me—invariably overturned boats which were not skilfully managed, I could not but feel apprehensive for the lives of the floating multitude. As the foaming wall of water dashed impetuously onward they were silenced, all being intently occupied in keeping their prows towards the wave, which threatened to submerge everything afloat; but they all vaulted, as it were, to the summit with perfect safety. The spectacle was of greatest interest when the Ægre had passed about half-way among the craft. On one side they were quietly reposing on the surface of the unruffled stream, while those on the nether portion were pitching and heaving in tumultuous confusion on the flood: others were scaling, with the agility of salmon, the formidable cascade.

"This grand and exciting scene was but of a moment's duration,—it passed up the river in an instant; but, from this point, with gradually diminishing force, size, and velocity, until it ceased to be perceptible, which Chinese accounts represent to be eighty miles from the city. From ebb to flood tide the change was almost instantaneous. A slight flood continued after the passage of the wave, but it soon began to ebb. My impression is that the fall was about twenty feet, but the Chinese say that the rise and fall at Hang-chow is sometimes forty feet. The maximum rise and fall at spring-tides is probably at the mouth of the river, or upper part of the bay, where the Ægre is hardly discoverable. In the Bay of Fundy, where the tides rush in with amazing velocity, there is at one place a rise of seventy feet; but there the magnificent phenomenon in question does not appear to be known at all. It is not, therefore, where tides attain their greatest rapidity, or maximum rise and fall, that the wave is met with, but where a river and its estuary both present a peculiar configuration and entrance to the advancing waters.

"A very short period elapsed between the passage of the Ægre and the resumption of traffic; the vessels were soon attached to the shore again, and women and children were occupied in gathering articles which the careless or unskilful had lost in the

aquatic *mêlée*. The streets were drenched with spray, and a considerable volume of water splashed over the banks into the head of the Grand Canal, a few feet distant."

THE MISSISSIPPI.

The disappointment which the traveller feels in looking upon this famous river for the first time is only exceeded by the counteracting impression which a journey down it leaves upon the mind. A more intimate acquaintance with the extent and resources of the country tributary to it, which repeated visits to points distributed along its entire course alone can give, only serves to heighten this impression, and " makes this wonder greater grow."

Discovered in 1672, the true source of the Mississippi (Father of Waters) was not fully determined until its exploration by Schoolcraft, who, in 1832, ascertained that it took its rise in a small lake situated in 47° north latitude and 94° 54′ west longitude from Greenwich. This lake, called by the French *Lac la Biche*, by recent geographers *Itasca*, is a beautiful sheet of water, of an irregular shape, about eight miles in length, situated among hills covered with pine forests, and is fed chiefly by springs. It is upwards of 1,500 feet above the ocean, and is at a distance of more than 3,000 miles from the Gulf of Mexico. The river drains an extent of territory which, for fertility and vastness, is unequalled upon the globe. This territory, termed the " Mississippi Valley," extends from the sources of the Mississippi on the north to the Gulf of Mexico on the south, and from the Alleghany Mountains on the east to the Rocky Mountains on the west. A more correct estimate of its area may be formed thus: —Take a position on the Gulf of Mexico, where it empties its accumulated waters, and run a line north-westward to the Rocky Mountains, whence issue the sources of the Arkansas, Platte, and other smaller streams; from this point, along the Rocky Mountains to the sources of the Yellowstone and Missouri

Rivers; around the northern sources of the latter river to the head-waters of Red River, a branch of the Assiniboin; around the sources of the Mississippi proper, to the head-waters of the Wisconsin and Illinois Rivers; between the confluents of the lakes and those of the Ohio, to the extreme source of the Alleghany River; along the dividing line between the sources of streams flowing into the Ohio River and those flowing toward the Atlantic; between the confluents of the Tennessee and those streams emptying into Mobile Bay; between the sources discharged into the Mississippi and those into the Tombigbee and Pearl Rivers; to the mouth of the Mississippi, and from its mouth to the outlet of the Atchafalaya: the whole presenting an outline of more than 6,000 miles, or an area of about 1,210,000 square miles. The Mississippi River is navigable for steamboats with but partial interruption, as far north as the Falls of St. Anthony, a distance of 2,037 miles; its course, however, is extremely crooked, and not unfrequently a bend occurs from twenty to thirty miles round, while the distance across is not more than a mile or two. In some instances, however, these distances have been shortened by what are termed "cut-offs," which are made by opening a narrow channel across the neck of a bend, when, on admitting the water, the current, running with such velocity, soon forces a channel both wide and deep enough for the largest steamboats to go through. The navigation is frequently rendered dangerous, owing to the mighty volume of water washing away from some projecting point large masses of earth, with huge trees. Some of the trees are carried down the stream. Others, again, are imbedded in the mud, with their tops rising above the water, and not unusually cause the destruction of many a fine craft. These are called, in river phraseology, "snags," and "sawyers." The whirls or eddies, caused by the striking peculiarities of the river in the uniformity of its meanders, are termed "points" and "bends," and have the precision, in many instances, of curves struck by the sweep of a compass. These are so regular that the flatboat-men frequently calculate distances by them: instead of by the number of miles, they esti-

mate their progress by the number of bends they have passed. A short distance from its source the Mississippi becomes a stream of considerable size. Below the Falls of St. Anthony it is half a mile wide; and below the Des Moines Rapids, to the mouth of the Missouri, it assumes a medial width and character. About fifteen miles below the mouth of the St. Croix River, the Mississippi expands into a beautiful sheet of water, called Lake Repin, which is twenty-four miles long, and from two to four miles broad. The islands, which are numerous, and many of them large, have during the summer season an aspect of great beauty, possessing a grandeur of vegetation which contributes much to the magnificence of the river. The numerous sand-bars are the resort during the season of innumerable swans, geese, and water-fowl. The upper Mississippi is a beautiful river—more so than the Ohio: its current is more gentle, its water clearer, and it is a third wider. In general it is a mile wide, but for some distance before commingling its waters with the Missouri it has a much greater width. At the junction of the two streams it is a mile and a half wide. The united stream flowing thence to the mouth of the Ohio has an average width of little more than three-quarters of a mile. On uniting with the Missouri it loses its distinctive character. It is no longer the gentle, placid stream, with smooth shores and clean sand-bars, but has a furious and boiling current, a turbid and dangerous mass of waters, with jagged and dilapidated shores. Its character of calm magnificence, that so delighted the eye above, is seen no more.

No one who descends the Mississippi for the first time receives clear and adequate ideas of its grandeur, and the amount of water it carries. If it be in the spring of the year, when the river below the mouth of the Ohio generally overflows its banks, although the sheet of water that is making its way to the Gulf is perhaps thirty miles wide, yet finding its way through deep forests and swamps, that conceal all from the eye, no expanse of water is seen but the width that is carved out between the woods on either bank, and it seldom exceeds, and often falls

short of, a mile. But when he sees, as he must in descending its entire length, that it swallows up one river after another, with mouths as wide as itself, without being at all affected in its width; when he notes the mighty Missouri, the broad Ohio, the St. Francis, White, Arkansas, and Red Rivers, all of them of great depth, length, and volume of water, swallowed in rapid succession ; when he sees this mighty river absorbing them all, and retaining a volume apparently unchanged, he begins to estimate aright the increasing depth of current that must roll on in its channel to the sea.—APPLETON'S *American Travel.*

THE MALAYS AT SINGAPORE.

THE Malays are the real indigenous sons of the soil, and contribute not a little to the general effect. They are not a handsome race. Their mahogany-coloured faces and high cheek-bones are usually accompanied by a remarkably shapeless and ugly mouth, which is rendered even worse by the detestable habit, common to both sexes, of chewing betel-nut, which reddens the teeth, lips, gums, and saliva of an uniform blood-colour, and has a most unsightly appearance. They usually affect bright colours in their costume—the men wearing a *baju* or jacket of thin material more or less variegated, and *sluar* or trousers of a similar character, while the head is enveloped in a *saputangan* or coloured handkerchief. With the women the *sarong* (literally a sheath) plays an important part. In unfrequented places it is the sole article of dress, and consists of a wide skirt or sack, of equal size above and below, fastened just beneath the breasts and reaching to the ankles, the shoulders and arms being left bare. In young girls the little sarong is commonly of a yellow colour, and indistinguishable at a distance from flesh-tint; it is simply fastened round the waist, and is the only garment, and a very graceful one, exhibiting the contour of the figure, especially when, as in some cases, it is ornamented with a quasi-classic pattern.

The Malays are very lazy, and averse to any, especially con-

tinuous, labour; and scarcely anything can induce them to undertake active employment. The women have universally a listless, shuffling gait, and languid appearance, which is very characteristic, and not improved by the use of slippers, which simply hang upon their toes without any fastening.

A Malay village is a common but picturesque and interesting feature of the neighbourhood of Singapore. Its situation and surroundings cannot fail to strike a stranger, and to be a matter of interest to the observant. The villages are always built upon platforms raised on wooden piles, either on the margin of the sea, or, more commonly, of rivers and creeks, or over mangrove swamps; and the water in all cases, at some period of the day, flows underneath their dwellings. It might be supposed that such damp situations would be unhealthy in the extreme; but such are always chosen by these people, who build clusters of wooden houses called *kampongs*, which are either approached in boats, or by a pathway of earth, raised above the level reached by the rising water. A background of cocoa-palms and bananas often adds beauty to the scene, and the dusky forms and faces moving about among the rickety dwellings on the platforms, or paddling about in canoes, give it a curious, semi-savage aspect. All the litter and dirt of the establishment is simply swept through the chinks in the floor, and without further trouble is thus washed away by the tide; an arrangement which well suits the character of the indolent Malays, who lazily lie upon their backs on the platform, while the little naked children make dirt-pies, or paddle about in minute cock-boats; the women, meanwhile, listlessly shambling about on their household duties. Such a village has a wild and uncivilized appearance, and yet there are not unfrequently curious and incongruous signs of luxury visible. Outside some of these houses may be seen vases of flowers, well cared for; and I have noticed here and there cushions laid out apparently for airing, whose ends were daintily embroidered.

Owing to their proximity to the water, the children are veritably amphibious in their habits. They hollow out logs of absurdly small dimensions, which do duty as canoes. These

they propel either with an impromptu paddle or with their hands; and they will dive like ducks, regaining their frail craft with astonishing skill. Such canoes often come up and surround the ships in New Harbour, their occupants diving for small coins thrown into the water, which they never fail to secure.—COLLINGWOOD's *Rambles of a Naturalist in the Chinese Seas.*

THE GULF STREAM.

IT is well known that the Gulf Stream has its origin in the Equatorial Current, which, starting from the Gulf of Guinea, flows for a time in a westerly direction, till it approaches Cape St. Roque. This great projection of the eastern coast of South America interrupts its onward progress, and causes it to divide into two branches; one of which follows the coast of Brazil, in a southerly direction; while the other continues its course to the north-west, until it reaches the Caribbean Sea. After passing into that basin, the great stream turns to the east, to enter the Atlantic again off Cape Florida. The high temperature of the Equatorial Current is owing to its origin in the tropical zone, its westward course being determined by the rotation of the Earth and the trade winds. On issuing from the Gulf of Mexico the stream is encased between the Island of Cuba and the Bahamas on one side, and the coast of Florida on the other. Here it meets the Atlantic in a latitude where the ocean waters have no longer the high temperature of the tropics, whereas the stream itself has acquired an increased warmth on the shoals of the Gulf. This accounts for the great difference of temperature between the waters of the stream and those of the ocean to the east of it; while the still greater cold of the sea-water on its western side, between the Gulf Stream and the continental shore, is explained by the great Arctic Current pouring down from Baffin's Bay, and skirting the shore of North America as far as the coast of Florida, until it is lost in that latitude under the Gulf Stream.

It has been ascertained, by the investigations of Dr. Bache,

that while the ocean-bed deepens more or less rapidly as we recede from the shore, forming a trough in which the Gulf Stream flows, this trough is limited on its eastern side by a range of hills trending in the direction of the current, outside of which is another depression or valley. Indeed the sea-bottom exhibits parallel ridges and depressions, running, like the shore of the continent itself, in a north-easterly direction. The water presents differences of temperature, not only on the surface, but at various depths below. These inequalities have been determined by a succession of thermometric observations along several lines, crossing the Gulf Stream from the shore to the ocean water on its eastern side, at intervals of about a hundred miles. The observations have been made first at the surface, and then at successively greater depths, varying from ten to twenty, thirty, one hundred, two hundred, and even three and four hundred fathoms. This survey (of Dr. Bache) has shown, that while the Gulf Stream has a temperature higher than that of the waters on either side, it is also alternately warmer and colder within itself, being made up as it were of distinct streaks of water of different temperatures. These alternations continue to as great a depth as the observations have been carried, and are found to extend even to the very bottom of the sea, where that has been reached. The most surprising part of this result is the abruptness of the change along the line where the two great currents meet each other—a change so abrupt that the boundary of the Arctic Current is now technically designated the "cold wall" of the Gulf Stream. So marked, indeed, is this boundary, that in 1861 Admiral Milne, of H.M.S. *Nile*, on entering the Gulf Stream found the water 70° at the bow, while it was only 60° at the stern.

As the Gulf Stream flows northward and eastward it gradually widens—being little more than forty miles off Cape Florida, one hundred and fifty miles off Charleston, and more than three hundred at Sandy Hook. As it spreads out, its temperature becomes lower and lower; but its surface warmth is still well marked at Sandy Hook, and its genial influence is felt even in Britain, and along the north-western shores of Europe onwards to

Spitzbergen. The inequalities of the bottom may be appreciated by the soundings off Charleston, where, from the shore to a distance of two hundred miles, the following depths were successively measured:—10, 25, 100, 250, 300, 600, 350, 550, 450, 475, 450, and 400 fathoms. The following statement of Dr. Bache may give some idea of the temperature of the stream in connection with its depth:—Off Sandy Hook, at successive distances from the coast of 100, 150, 200, 250, 300, 350, and 400 miles, the temperature near the surface, to a depth of thirty fathoms, averaged 64°, 65°, 66°, 64°, 81°, 80°, and 75° Fahr.; at a depth between forty and a hundred fathoms it averaged 50°, 52°, 50°, 47°, 72°, 68°, and 65° Fahr.; and at a depth below three hundred fathoms it averaged 37°, 39°, 40°, 37°, 55°, 57°, 55° Fahr. The rapid rise of the temperature after the fourth sounding indicates the position of the "cold wall" and the entrance into the waters of the current.—*Compiled.*

INDIAN DWELLINGS NEAR THE AMAZON.

A GREAT part of the land in the valley of the Amazon, even far up into the forest, is overflowed; and single logs are thrown across the streams and pools, over which the inhabitants walk with as much security as on a broad road, but which seem anything but safe to the new-comer. After we had gone a little way we came to an Indian house on the border of the wood. Here we were very cordially invited to enter, and had again cause to comment on the tidy aspect of the porch, which is their general reception-room. A description of one of these dwellings will do for all. Their materials are drawn from the forest about them. The frames are made of tall, slender tree-trunks, crossing each other at right angles. Between these are woven long palm-leaves, making an admirable thatch, or sometimes the walls are filled in with sand. The roof overhangs, covering the wide, open porch, which extends the length of one side of the house, and is as deep as a good-sized room. It is usually left open on the

as well as on front. Within, the rest of the house is ɪd off into one or more chambers, according to its size. I not penetrated into these, but can bear testimony to the cleanliness and order of the outer room. The hard mud is cleanly swept, there is no litter about; and, except for osquitoes, I should think it no hardship to sling my ham- for the night under the thatched roof of one of these tive veranda-like apartments. There is one element of dirt on in the houses of our own poor which is absent here. ɪd of the mass of old musty bedding, a nest for vermin, the ɪs have their cool hammocks slung from side to side of the

One feature in their mode of building deserves to be men- l. Owing to the submerged state of the ground on which ive, the Indians often raise their houses on piles sunk in the . Here we have the old lacustrine buildings, so much dis- l of late years, reproduced for us. One even sees sometimes e garden lifted in this way above the water!—AGASSIZ: *A ey in Brazil*.

THE STEPPES OF EASTERN EUROPE.

e south-east of Europe, the low plains that assume the name *ppes* are highly characteristic. They are elevated about feet above the level of the Black Sea. Through them ɪl very large rivers run, and they reach back towards the ; Ocean with little interruption, rising scarcely at all, but ly interrupted by very low hills. These steppes are ɪmena sufficiently remarkable to deserve a few words of ption; and they cannot be visited, even in the most cursory er, without exciting feelings of astonishment on the part of hitherto only familiar with the broken surface of the greater ɪf civilized and cultivated Europe.

these steppes the seasons are very strongly marked. In the ; and early summer the land is carpeted by flowers. In ɪmmer it becomes parched, after yielding as food or hay a ɪpply of mixed grasses, which may be stored for winter use;

but in the latter part of summer and during autumn it is perfectly bare and burned up. In winter, which begins in October, the whole area becomes covered with snow, and this remains until spring. There are no trees on those great plains, and no enclosures of any kind; but at intervals the surface is broken by hollows scooped out of the plain, to a depth varying generally from fifty to a hundred feet; and in most of these are villages, and some cultivation, especially on the borders of the plain and in the vicinity of the coast, or of the great rivers. There are, however, no roads, and indeed there is no material for making them. One may travel for hundreds of miles over the level surface of the ground—over the turf in spring, through the thick dust in summer, and over the snow in winter—without seeing a single object rising above the general surface of the plain. The post-houses, at equal and distant intervals, are the only signs of humanity and civilization; and the cry of the bustard is one of the few sounds that break the terrible monotony and stillness. The dead level of thin pasture, even if luxuriant, soon fatigues the eye; and when the horses and cattle are away there is absolutely nothing for the eye to rest upon. The travelling across the steppes, conducted with great rapidity, in a kind of light cart, is thus not so difficult as it is tiresome. But it is only safe in summer; for when the snows cover the ground, not only does it become dangerous, from the wolves that take refuge in the hollows, but almost impossible, owing to the absence of landmarks. It is understood that an entire *corps d'armée* was lost in the steppes between the Dnieper and the Don, while attempting to reinforce the Russian army in the Crimea, during the war with England and France.

Throughout the southern part of the steppes and in much of the country to the east, there is either a thin soil or no soil at all. This condition, however, gives place in the interior to a remarkable and extremely important black soil, of extraordinary richness, capable of yielding inexhaustible supplies of wheat without any artificial treatment or any agriculture, except of the rudest kind. These parts of the steppes now supply enormous quantities of corn to the great markets of the world; and when opened, as they soon

will be much more completely, by railroads, and steam navigation on the great rivers, it is certain that both Russia and the rest of Europe will be great gainers. A wide range of the plains is, however, hopelessly barren, and all of them depend much on the occasional rains. When these fail the heat is excessive, and the sun rises and sets like a globe of fire, while during the day a thick mist covers the earth. The drought soon becomes excessive—the small supplies of water, found at other seasons in the hollows, fail altogether; the air is filled with dust and impalpable powder; and the cattle and horses perish by thousands. In the winter the case is equally bad: fearful storms often sweep over the desolate plains, and the dry snow is driven by the gales with a violence which neither man nor animal can resist. These storms are especially frequent in the vast Aralo-Caspian plain, which is depressed below the general level of the sea, and which is, to a great extent, an ocean of shifting sand.—ANSTED'S *Physical Geography*.

THE UPPER AMAZON.

THE Upper Amazon, or Solimoens, is always spoken of by the Brazilians as a distinct river. This is partly owing to the direction it takes at the fork of the Rio Negro—the inhabitants of the country, from their partial knowledge, not being able to comprehend the whole river-system of the Amazon in one view. It has, however, many peculiarities to distinguish it from the lower course of the river. The trade-wind or sea-breeze, which reaches, in the height of the dry season, as far as the mouth of the Rio Negro, 900 or 1000 miles from the Atlantic, never blows on the upper river. The atmosphere is, therefore, more stagnant and sultry, and the winds that do prevail are of irregular direction and of short duration. A great part of the land on the borders of the Lower Amazon is hilly; there are also extensive *campos* or open plains, and long stretches of sandy soil clothed with thinner forests. The climate, in consequence, is comparatively dry—many months in succession during the dry season passing

without rain. All this is changed on the Solimoens. A fortnight of clear, sunny weather is a rarity.

The whole region through which the river and its affluents flow, after leaving the eastermost ridges of the Andes, which rise like a wall from the level country 240 miles from the Pacific, is a vast plain about 1000 miles in length and 500 or 600 in breadth, covered with one uniform, lofty, impervious and humid forest. The soil is nowhere sandy, but always either a stiff clay, alluvium, or vegetable mould; which latter, in many places, is seen in sections of the river-banks to be twenty or thirty feet in depth. With such a soil and climate, the luxuriance of vegetation, and the abundance and beauty of animal forms, which are already so great in the region nearer the Atlantic, increase on the upper river. The fruits, both wild and cultivated, common to the two sections of the country, reach a progressively larger size in advancing westward, and some trees which blossom only once a year at Pará and Santarem, yield flower and fruit all the year round at Ega. The climate is healthy, although one lives here as in a permanent vapour-bath. The country along the river is a magnificent wilderness, where civilized man, as yet, has scarcely obtained a footing; the cultivated ground from the Rio Negro to the Andes amounting only to a few score acres. Man, indeed, in any condition, from his small numbers, makes but an insignificant figure in these vast solitudes.

It may be mentioned that the Solimoens is 2130 miles in length, if we reckon from the source of what is usually considered the main stream—Lake Lauricocha, near Lima; but 2500 miles by the route of the Ucayli, the most considerable and practicable fork of the upper part of the river. It is navigable at all seasons by large steamers for upwards of 1400 miles from the mouth of the Rio Negro; but during the rainy season the navigation is somewhat dangerous, as the tearing current, two or three miles in width, bears along a continuous line of uprooted trees and islets of floating vegetation.—*Adapted from* BATES'S *Naturalist on the River Amazon.*

GEOLOGICAL.

GEOLOGY: ITS AIM AND OBJECT.

Geology (from two Greek words—*ge*, the earth; and *logos*, discourse, or reasoning) may be defined as that department of natural science which treats of the mineral structure of our globe. Its object is to examine the various rock materials of which our planet is composed; to describe their appearance and relative positions; to investigate their nature and mode of formation, the changes they have undergone and are still undergoing; and, generally, to discover the laws which seem to determine their characters and arrangements.

Over whatever portion of the globe we travel, we find it made up of rocks and rocky substances. The dry land is composed of them, and if we go to the sea-shore, we see them shelving away beneath the ocean, or rising up in mid-water as shoals and reefs and islands. Whether we pierce the hills for railway tunnels, or sink into the plains for wells and coal-mines, we pass alike through rocks differing in colour, composition, and consistence. The fair inference, therefore, is, that all the exterior or accessible portion of our planet consists of *rocks;* and under this term geologists comprehend in a technical sense all mineral substances, whether loose and shifting like sand, soft and plastic like clay, or hard and crystalline like marble.

These rock-matters, as the most casual observer must be aware, differ widely in different localities. In our own island, for instance, if we dig for wells or cut for railways, in and around London we meet with thick beds of sand, clay, and gravel; in Kent and Surrey the hills and high grounds consist of chalk; in

Derbyshire they are chiefly limestones and marbles; in Durham and Northumberland we have sandstones, and coals, and ironstones; in the neighbourhood of Edinburgh, hills of basalt and greenstone; in Forfarshire the prevailing rocks are red and gray sandstones; in Perthshire, as in Wales, we have abundance of roofing slates; and in Aberdeenshire there are vast exhibitions of granites and granitic compounds. It must be obvious to the least reflecting, that there have been causes in nature for this great variety and diversity of rock-substances; and to discover these causes and their modes of operation is one of the main objects of geological inquiry.

Again: when we investigate these rocks more closely, we find that a large proportion is arranged in beds or layers, one above another, like the courses in a building. Such layers of rock are technically spoken of as *strata* (from the Latin word *stratum*, strown or spread out; plural *strata*), and rocks so disposed are said to be *stratified*. One cannot sink a well or pass through a railway cutting without observing this stratiform arrangement of the Earth's materials; just as we see the muds, and sands, and gravels of a river estuary spread out one above another in a similar way. As nature now operates in laying down sedimentary matter, bed above bed, and layer above layer, in lakes, and estuaries, and seas; so we may rightly infer that all stratified rocks, as sandstones, limestones, clays, and so forth, were formed in like manner through and by the agency of water. In other words, we regard the stratified rocks as the consolidated sediments of former ages; and geology endeavours, from an examination of their distribution, composition, and character, to map out the areas of the waters in which, and the conditions under which, they were deposited.

Besides the stratified rocks, the observer will perceive another set, not arranged in layers, but rising up in hard and homogeneous masses. These are the granites, the basalts, and greenstones of our hills, in which no lines of sedimentary deposit appear, and which have evidently been formed in a way altogether different from the clays, and sandstones, and limestones already alluded to. When we turn to the burning mountain or volcano, and examine

ı that has been ejected during times of eruption, we find d and solidified into rock-masses, so precisely analogous ts and greenstones, that it is even sometimes difficult to ıish between them. Here then, as in the former instance, logist is entitled to infer that the *unstratified* rocks have oduced in bygone ages just like the lavas of the present 1 he calls them *igneous* (Lat. *ignis*, fire), as having been through and by the agency of fire. As, in existing nature, : action, wherever it occurs, is accompanied by earth- and subterranean convulsions, which raise one portion of und and depress another, cause rents and fissures which n filled with molten rock-matter, and produce irregularity ersity of the land surface; so geology endeavours to dis- ı the unstratified rocks their effects in creating hill-ranges, g up the stratified rocks, and everywhere producing irregu- nd diversity in the solid framework of the globe.

further: on examining more intimately, the observer de- ı many of the stratified rocks the petrified remains of and animals;—stems, branches, leaves, and fruits of the ıd shells, crusts, scales, teeth, and bones of the other. In ; nature, plants and animals are drifted by rivers from the ıd carried down to estuaries and the ocean, there to be ed among their silts and sediments; and plants and inhabiting the waters die, and are imbedded in a similar in the same deposits. Applying his knowledge of the to the interpretation of the past, the geologist examines ıpares these petrified remains, and endeavours to arrive at ledge of the plants and animals to which they belonged— ning whether they inhabited the land or the waters, : they were fresh-water or marine, and, generally, the l or geographical conditions under which they grew and ed.

he means above enumerated—namely, by an examination rocks themselves, the areas over which they are spread, ıickness and alternations, and the kinds of plants and they contain—the geologist strives to ascertain the past

conditions of the Earth, the various shiftings of sea and land, the life by which these were respectively peopled, and the geographical conditions that accompanied such mutations. In other words, he tries to read the history of our globe as contained in its rocky record, describing its external aspects at each successive stage in time, just as the geographer depicts its existing arrangements of sea and land, with all their varied garniture of vegetable and animal existences. Geology, as has been well said, is but the physical geography of former ages.

The deciphering of the world's history in time constitutes the *theoretical* or *scientific* aspect of geology, and, as such, presents an attractive and varied field of intellectual research. The repeated changes to which the Earth's surface has been subjected, and the wonderful forms by which the land and water have been successively peopled, must ever present sufficient attraction to the inquiring mind; while the observation its facts necessarily call forth, and the reasoning its problems require, must in like manner exalt geology to the position, perhaps, of the noblest and most comprehensive of the natural sciences. Beyond its theoretic interest, the science is also of vast *industrial* or *practical* importance. All the minerals and metals, the knowledge and use of which are so essential to the progress of civilization, are derived from the earth. As these do not occur indiscriminately, but are found only in certain positions, and associated with certain classes of rocks, it is indispensable to ascertain their position, their modes of occurrence, their abundance, and the facility with which they can be obtained. This, geology alone can do with certainty and satisfaction; hence its great value to civilized nations, and especially to countries which, like Britain, derive so much of their importance from their mineral and metallic treasures. Combining its theoretical and practical importance, geology has recommendations to its cultivation which few of the other sciences possess;—has all the interest of a wondrous Past to attract, and all the value of a sterling Present to incite to its study and acquirement.

METHODS OF GEOLOGICAL INTERPRETATION.

[HE method of interpreting the geological record rests upon the imple principle that rocks were made as they are now made, and hat life lived in olden time as it now lives; and further, the nind is forced into receiving the conclusions arrived at by its wn laws of action. For example, we go to the sea-shore, and bserve the sands thrown up by the waves; note how the wash f the waves brings in layer upon layer, though with many rregularities; how the progressing waters raise ripples over the urface, which the next wave buries beneath other sands; how uch sand-beds gradually increase in extent; how they are often ontinued out scores of miles beneath the sea, as the bottom of he shallow shore waters; and that these submerged beds are ormed through constant depositions from the ever-moving waters. Then we go among the hard rocks, and find strata made of sand n irregular layers, much like those of the beach; and on opening ome of the layers we discover ripple-marks covering the surface, s distinct and regular as if just made by the waves; or, in an-ther place, we find the strata made up of regular layers of sand nd clay alternating, such as form from the gradual settling of he muddy material emptied into the ocean by rivers; or, in nother place, layers of rounded water-worn pebbles, such as occur beneath rapidly-moving waters, whether of waves or rivers. We remark that these hard rocks differ from the loose sand, clay, or pebbly deposits simply in being consolidated into rock. Then, in other places, we discover these sand-deposits in all states of consolidation, from the soft, movable sand, through a half-compacted condition, to the gritty sandstone; and further, we discover, perhaps, the very means of this consolidation, and see it in its progress, making rock out of sand or clay. By such steps as these the mind is borne along irresistibly to the conclusion that rocks were slowly made through commonplace operations.

We may see, on another sea-shore, extensive beds of limestone forming from shells and corals, having as firm a texture as any

marble; we may watch the process of accumulation from the growth of corals and the wear of the waves, and find the remains of corals and shells in the compact bed. If we then meet with a limestone over the continent containing remains of corals, or shells, no firmer, not different in composition, but every way like the coral reef rock or the shell rock of other regions, the mind, if allowed to act at all, will infer that the ancient limestone was as much a slowly-formed rock, made of corals or shells, as the limestone of coral seas.

In a volcanic district, we witness the melted rock poured out in wide-spread layers and cooling into compact rock, and learn, after a little observation, that just such layers, piled upon one another, make the great volcanic mountain, although it may be 10,000 feet in height. We remark, further, that the fractured crust in those regions has often let out the lava to spread the surface with rock, even to great distances from the crater. Should we, after this, discover essentially the same kind of rock in wide-spread beds, and trace out the fractures filled with it, leading downward through the subjacent strata, as if to some seat of fires, and discover marks of fire in the baking of the underlying beds, we use our reason in the only legitimate way when we conclude that *these* beds were thrown out melted, even though they may be far from any volcanic centre.

If we see skeletons buried in sand and clay that we do not doubt are real skeletons of familiar animals, and then in a bed of rock discover other skeletons, but of unfamiliar animals, yet with every bone a true bone in form, texture, and composition, and every joint and limb modelled according to the plan in known species, we pass, by an unavoidable step, to a belief that the latter are relics of animals as well as the former, and that they lie in their burial-place, although that burial-place be now the solid rock.

In using the present in order to reveal the past, we assume that the forces in the world are essentially the same through all time; for these forces are based on the very nature of matter and could not have changed. The ocean has always had its waves, and those waves have ever acted in the same manner. Running water

on the land has ever had the same power of wear and transportation and mathematical value to its force. The laws of chemistry, heat, electricity, and mechanics have been the same through time. The plan of living structures has been fundamentally one, for the whole series belong to one system, as much almost as the parts of an animal to the one body; and the relations of life to light and heat, and to the atmosphere, have ever been the same as now.

The laws of the existing world, if perfectly known, are consequently a key to the past history. But this perfect knowledge implies a complete comprehension of Nature in all her departments—the departments of chemistry, physics, mechanics, physical geography, and each of the natural sciences. Thus furnished, we may scan the rocks with reference to the past ages, and feel confident that the truth will declare itself to the truth-loving mind. As this extensive range of learning is not within the grasp of a single person, special departments have been carried forward by different individuals, each in his own line of research; for geology as it stands is the combined result of the labours of many workers. But the system is now so far perfected that the ordinary mind may readily understand the great principles of the science, and comprehend the unity of plan in the Earth's genesis. —DANA'S *Manual of Geology.*

VOLCANOES: THEIR NATURE AND CHARACTERISTICS.

EVERY one is less or more acquainted with the aspect and nature of a *Volcano* or burning-mountain. Whether he has seen one or not, his readings and hearings lead him to associate with his idea a mountain of a conical form having a *crater* or orifice of eruption at top, and from which at intervals are emitted clouds of vapour and flame, showers of dust and ashes, and streams of *lava*, or molten rock-matter. The outline may not be strictly conical, yet such is the form which it usually assumes; there may be more craters or orifices than one, some being *central* or near

the top, and others *lateral* or placed along the sides; and the substances discharged may be very heterogeneous—now highly heated steam and sulphurous vapours, now dust and cindery matters called *scoriæ*, now fragments of rock (lapilli and volcanic bombs), and anon wellings-out of lava, sometimes extremely fluid, and at others slaggy and cindery. Notwithstanding such local and periodic differences, there is, on the whole, a great similarity in aspect and operation among all volcanoes, which leads to the belief that they belong to one brotherhood, and to the same system of causation.

It is usual to speak of *lava-cones*, *tufa-cones*, *cinder-cones*, and *mixed cones*, according as a mountain is chiefly composed of one or other of these substances, or of a mixture of all of them; but, as may be anticipated, the mixed cones are by far the most prevalent, and the distinction is mainly valuable in assisting the observer to determine the composition of distant or inaccessible volcanoes. Thus the slope of a lava-cone is very gentle—from 3 to 10 degrees; that of a tufa-cone from 15 to 30 degrees; of a cinder-cone from 35 to 45 degrees; and that of a mixed cone usually gentle beneath, but topped with a steep peak of loose and scoriaceous materials. Again, some are strictly *sub-aërial*—that is, take place on the dry land; and others *sub-aqueous*—that is, operate under the waters, or but rarely manifest themselves at the surface;—yet both seem to act in a similar way, and to discharge similar products. Further, some are ceaselessly *active;* others become active only at long intervals, and are said to be *dormant;* while others have been so long dormant and without symptoms of activity that they are regarded as *extinct*. Between the existing and the extinct there is every grade of activity, just as among the extinct there is every degree of antiquity. We are thus led from the active craters of Etna and Vesuvius back to the extinct cones of Central France and the Rhine, which, in their crateriform domes and rugged lava-streams, still retain the aspect of volcanoes; from these back through the Apennines and Alps; from the Alps to the Pyrenees; and from the Pyrenees to the Scandinavian and older mountain-ranges, which have all

had the same origin, though now their craters and domes are obliterated, and their outlines have undergone a thousand modifications from those denuding agencies of air and water which have operated upon them during untold ages.

In looking upon the more ancient hills, as well as upon existing volcanoes, a question naturally arises—Are these elevations chiefly upliftings of the Earth's solid crust, or are they accumulations of igneous matter that have been discharged from its interior? In other words, are mountains and mountain-ranges mainly produced by upheavals or swellings-up of the Earth's rocky crust, or have they been accumulated on the surface by repeated discharges of volcanic matter? Much controversy has existed on this point, and many arguments have been adduced on both sides; but the truth seems to be, that the forces from within have acted in both ways—partly by elevation of the stratified crust, but chiefly by the accumulation of erupted materials. In this view every mountain and mountain-range becomes a matter of slow and gradual growth, every shower of ashes and stream of lava adding to the bulk of the isolated cone, and every new cone adding another link to the mountain-chain. We have no exact measure of this slow and gradual accumulation, but judging from the small amount that has been added to Etna and Vesuvius during the historical period, many of the existing volcanoes must be of vast antiquity; and when we carry our retrospect, stage by stage, through the extinct volcanic hills to the ancient mountain-ranges, the mind is altogether unable to grasp the cycles that must have elapsed since their formation.

Presuming, then, that volcanic hills are chiefly masses of accumulation and not of upheaval, the repeated eruptions that take place must necessarily fracture and derange the continuity of the surrounding district, and thus every igneous centre is marked by such accompaniments as hot-springs, boiling mud-springs, discharges of sulphurous gases, and the like; better known, perhaps, as the *suffioni* and *solfataras* of Italy, and the *salses*, *hornitos*, and *hervideros* of Mexico and South America. Such minor discharges are the normal accompaniments of all active volcanoes,

and long after activity has ceased they form the residual phenomena, and indicate by their declining force and number the distance both in time and place of the fiery forces that once operated below. No doubt springs of considerable temperature may exist in districts long since quiescent, and now far removed from volcanic activity (those of Bath and the Pyrenees, for example); but the monticules thrown up by mud-volcanoes and escapes of heated and sulphurous vapours generally mark either the proximity of igneous activity or the comparative recentness of its manifestation in the area. The whole are merely indications of the same thermal agency—that internal fire-force which Humboldt has so appropriately included under the name of Vulcanism or Vulcanicity.—Page—*Geology for General Readers.*

THE EARTHQUAKE: ITS NATURE AND FUNCTION.

The next great manifestation of vulcanism is the *Earthquake*—a distinction made in scientific as well as in every-day language; for though the earthquake is generally the close concomitant of the volcano, yet its throes may be felt in districts where no volcano has existed for ages. This motion, as the name implies, is a quaking or trembling of the earth—varying from the gentlest tremor to agitations so violent that the solid crust is fractured, one portion thrown up and another thrown down, the sea-bed uplifted into dry land, and the dry land submerged beneath the waters. The phenomena that accompany earthquake convulsions are extremely varied. Occasionally they are preceded by an unusual stillness and sultriness of the atmosphere; low, hollow rumblings, more audible than felt; and great restlessness and terror among birds and mammals, as if the instincts of these were keener than human perception. At other times there is no premonition, but all at once a few smart concussions passing away in a certain direction, or not unfrequently spreading from a central point in diminishing intensity. On other occasions, however, the momentary concussions return after a short pause, with

increased vehemence; and then there is a perceptible undulation of the Earth's crust, as if it were passing away from beneath the feet of the spectator—an uplift, a shock, a series of giddy shocks, and the work of destruction. Though continuing at most for only a few seconds, these violent shocks generally result in extensive fracturings of the rocky crust. Yawning rents and fissures, gaseous discharges, burstings-forth of new springs, absorption of streams, changes in the course of rivers, elevations of the sea-bed, submersions of the dry land, and the conversion of populous cities into masses of ruin and rubbish, are the not unfrequent but destructive effects of the earthquake. At times, too, as the water in a vessel that has been agitated and then brought suddenly to rest strikes forcibly over its margin, so the sea, its floor having been shaken, is frequently thrown into violent waves (earthquake-waves), which rush forward against the land to the height of 40, 50, or 60 feet, and sweep everything into destruction before them. The wall-like wave that rolled in upon the coasts of Portugal after the great Lisbon earthquake in 1755 was estimated at 60 feet high; and those (three in number) that desolated the town of Simoda (Japan) in 1854 were little inferior in violence and dimensions.

On the whole, the effects of the earthquake are much more disastrous than those of the volcano. The discharges of the one, being at considerable altitude, are chiefly felt for a few miles round its crater or in long narrow streams down its sides; but the shocks of the other convulse for leagues, and at all levels, and alike over land and sea. The two, however, are usually in close connection; and in centres of igneous activity, when the volcano begins to discharge, the convulsions of the earthquake cease, or at all events lose much of their intensity. The one acts as a sort of safety-valve to the other, and this necessarily so if we regard them as both arising from the same deep-seated source of igneous intensity.—PAGE: *Geology for General Readers.*

EARTHQUAKES IN SOUTH AMERICA.

Along the whole coast of Peru the atmosphere is almost uniformly in a state of repose. It is not illuminated by the lightning's flash, nor disturbed by the roar of the thunder; no deluges of rain, no fierce hurricanes destroy the fruits of the fields, and with them the hopes of the husbandman. But the mildness of the elements above ground is frightfully counterbalanced by the fury of those within the rocky crust.

Lima is frequently visited by earthquakes, and several times the city has been reduced to a mass of ruins. At an average, forty or forty-five shocks may be counted on in the year. Most of them occur in the latter part of October, in November, December, January, May, and June. The slighter shocks are sometimes accompanied by a noise, at other times they are merely perceptible by the motion of the earth. The subterranean noises are manifold. For the most part they resemble the rattling of a heavily-loaded waggon, driven rapidly over arches. They usually accompany the shock, seldom precede it, and only in a few cases do they follow it, sounding like distant thunder. Of the movements, the *horizontal vibrations* are the most frequent, and they cause the least damage to the slightly-built habitations. *Vertical shocks* are most severe; they rend the walls and raise the houses out of their foundations. The greatest vertical shock I ever felt was on an evening in July 1839, when I was in the old forest of the Chanchamoyo territory. Before my hut there was an immense trunk of a felled tree, which lay with its lower end on the stump of the root. I was leaning against it and reading, when suddenly, by a violent movement, the trunk rose about a foot and a half, and I was thrown backwards over it. By the same shock the neighbouring river, Aynamayo, was dislodged from its bed, and its course thereby changed for a considerable length of way. I have had no experience of the *rotatory movements* of earthquakes. According to the statements of all who have observed them, they are very destructive, though uncommon.

In Lima I have often felt a kind of concussion which accords with that term in the strictest sense of the word. This movement had nothing in common with what may be called an oscillation, a shock, or a twirl: it was a passing sensation, similar to that which is felt when a man seizes another unexpectedly by the shoulder and shakes him; or like the vibration felt on board ship when the anchor is cast, at the moment it strikes the ground. I believe it is caused by short, rapid, irregular horizontal oscillations. The irregularity of the vibrations is attended by much danger; for very slight earthquakes of this kind tear away joists from their joinings, and throw down roofs, leaving the walls standing, which on all other kinds of commotion usually suffer first, and most severely.

Atmospheric phenomena are frequent, but not infallible prognostics of an earthquake. I have known individuals in Lima, natives of the coast, who were seldom wrong in predicting an earthquake, from their observation of the atmosphere. They experience a feeling of anxiety and restlessness, a pressure of the breast, as if an immense weight were laid on it. A momentary shudder pervades the whole frame, or there is a sudden trembling of the limbs. I, myself, have several times experienced this foreboding, and there can scarcely be a more painful sensation. The atmospheric phenomena during and after an earthquake are very different. In general the atmosphere is tranquil, but occasionally a stormy agitation is the harbinger of a change. Slight shocks are usually only local, and are not felt beyond the limits of a few square miles. The serious commotions which take place on the Peruvian coast appear to acquire progressively greater extension, but only in the southerly and northerly directions. A shock of which Lima is the centre, though felt fifty leagues towards the north and south, may nevertheless be imperceptible in the easterly direction (towards the mountains), at the distance of ten or twelve leagues.

The effect of earthquakes on the fertility of the soil is sometimes remarkable. Numerous observations tend to show that after violent commotions luxuriant lands often become barren

wastes, and for several years produce no thriving vegetation. Several quebradas in the province of Truxillo, formerly remarkable for their fertility in grain, were left fallow for twenty years after the earthquake of 1630, as the soil would produce nothing. Similar cases occurred at Sape, Huaũra, Lima, and Yea. All kinds of grain appear to be very susceptible to the changes produced in the soil by earthquakes. Cases are recorded in which, after slight shocks, fields of maize in full bloom have withered; and in the course of a day or two the crops have perished.—DR. VON TSCHUDI: *Travels in Peru.*

MOUNTAINS AND VALLEYS: THEIR ORIGIN.

AMONG the many forms of scenery which vary the surface of the Earth, none fixes itself more firmly on the memory and the imagination than that of the hills and mountains. The aspect of the lower grounds is liable to constant change. We see the waves wearing down the shore, and the rivers ever and anon devastating the meadows. Man himself does much to transform the landscape: he ploughs up peat-mosses, cuts down forests, plants new woodlands along the hill-sides, covers the valleys with corn-fields and orchards, graves the country with lines of roadway, and builds his cottages, villages, sea-ports, and towns. But high above the din and stir of these changes, the great mountains rise before us with still the same forms of peak and crag that were familiar to our forefathers long centuries ago. Amid the fleeting outlines of the lowlands these alone seem to defy the hand of Time. And hence "the everlasting hills" and "ancient mountains" have ever been favourite emblems of permanence and grandeur.

Not that signs of revolution failed to be perceived in the early ages among the crags and valleys of the hills. There is an air of ruin and waste about these high grounds which no eye can miss. But the cleaving of their ravines, the scarping of their precipices, the opening of their valleys, and the strewing of their slopes with piles of loose rock, were looked upon vaguely as the

complex result of the first grand upheaval of the mountains out of chaos.

Sometimes, however, the traces of destruction were too marked to be assigned, even by the popular mind, to the first creation of all things. The hills looked as though, long after their birth, they had been rent in twain; the cliffs were shattered and broken, as if they too had suffered from a like catastrophe; the huge fragments of crag and mountain scattered over the declivities, or lying thickly in the valleys below, seemed all to tell of some conflict, later, indeed, than the making of the world, yet lost in an antiquity far beyond the records of man. To the influence of scenery of this kind on the mind of a people at once observant and imaginative, such legends as that of the Titans should in all likelihood be ascribed. . . . Nor would it be difficult to trace a close connection between the present scenery of our own country and some of the time-honoured traditionary stories of giants and hero-kings, warlocks and witches, or between the doings of the Scandinavian Hrimthursar, or Frost-Giants, and the more characteristic features of the landscapes and climate of the north.

But apart from the region of fable and romance, it is impossible to wander among the glens and solitudes of a wild, mountainous tract, without feeling a certain vague awe, not merely on account of the magnitude or loneliness of the surrounding scenery, but from the mystery that seems to hang over its origin. The gentle undulations of a lowland landscape may never start in the mind a passing thought; but we are arrested at once by the stern, broken features of the hills, and cannot help asking ourselves how they came into being.

To such a question the natural answer is sought in vast primeval convulsions, that suddenly tossed up the mountains, rent open ravines and glens for the rivers, and unfolded wide valleys to receive and remove the drainage of the country. There is an air at once of simplicity and of grandeur about this explanation, which has made it a favourite and popular one. It deals with that dream-land of conjecture and speculation lying far beyond the pathways of Science, where one has no need of facts for either the

foundation or superstructure of his theory. It thus requires no scientific knowledge or training; it can be appreciated by all, and may be applied to the history of a mountain-chain by one to whom the very name of geology is unknown. No man, indeed, who is aware of what has been ascertained of the history of the Earth can hold this popular notion to the full; for it is now well known that the mountains are of many different ages—that some of them were rent and worn down before others had begun to be, and that the rocks which form the present surface of the Earth are the result of many successive ages of geological change.

To whatever source the origin of the existing configuration of the surface is to be traced, the result of the whole has been a system of the most nicely-adjusted symmetry. Hill and mountain, valley and glen, seem each as if made to fit in closely with its neighbours. One main office of land is to serve as a channel, in which a part of the water which rises from the sea into the clouds may find its way once more to the deep. The manner in which this task is accomplished, familiar and even common-place though it may be, can hardly be thoughtfully contemplated without wonder. From the high grounds the gathered rains and springs descend in hundreds and thousands of water-courses, which, from the tiniest runnel up to the ample river, are all arranged in the closest harmony with each other, and with the whole orderly system of which they form a part. This well-balanced symmetry cannot but have resulted from some general cause, acting uniformly throughout the land which it fashioned for its own ends.

The form of the valleys may vary indefinitely without disturbing the general symmetry. They may be wide, open, smooth, with gently shelving sides; or they may be only narrow gorges, in which the rivers toil between naked walls of rock. Merely from the map one cannot tell where the valleys are wide, and where narrow. The most precipitous ravines fall easily into the general plan, and lie in the paths of the streams just as naturally and unconstrainedly as do the widest straths. Nor should we fail to remark that the ground-plan of the valleys, as defined on

a map by the courses of the streams, is marked everywhere by the same great features, whether the region be one of mountains or low plains. If the map has no hill-shading it may be impossible to tell which are the higher mountain-ranges and which the lower groups of hills and plains, so uniform is the disposition of the valleys and water-courses apart from relative height.

We have to inquire by what probable means this harmonious grouping of hill, and valley, and water-course was brought about. Two explanations have been given. One calls in the aid of old terrestrial *convulsions*, and looks on the valleys and ravines as due to fractures and subsidences or upheavals of the Earth's crust; the other, while far from ignoring the influence of subterranean movements, holds that these have not been the chief cause in determining the present form of the ground, but that the valleys are due in the main to *denudation*, or the erosive action of rains, streams, ice, and other sub-aërial forces....

It should be borne in mind that, in dealing with the past history of our planet, the element of *time* ought never to be lost sight of. To turn away from the known and visible causes of change, and to imagine the former presence of others far more stupendous, because the results achieved seem otherwise inexplicable, is to substitute mere speculation for inductive reasoning. In all such attempts we make the fatal error of forgetting that, in the geological history of our globe, *time is power*. It may not be easy to get thoroughly rid of the natural tendency to associate great effects with great causes; but if one can free himself from this prejudice, he will probably be led, in the spirit of Hutton (the founder of Inductive Geology), to perceive that there appears to be no great change in the configuration of the land which may not have been brought about by the working of those slow everyday processes which are in progress now.

There can be no dispute regarding the abundance of the upheavals, subsidences, and dislocations which the crust of the Earth has undergone; but that our valleys and ravines are not mere cracks, would seem to be put beyond dispute by the fact that for one valley which happens to run along the line of a dislocation,

there are, I daresay, fifty or a hundred which do not. Moreover, it can be shown that out of every valley and glen a great mass of solid rock has been carried bodily away, and that even the highest mountain-tops have suffered a similar loss. If we could restore the missing material, we should, in truth, be able to fill up the glens and valleys again, so that the mountainous parts of the country would thus be turned into rolling table-lands.

But perhaps the most evident argument against the doctrine of fracture and convulsion, and in favour of the Huttonian theory of erosion (Lat. *erosus*, gnawed or worn out), is to be found in the very grouping of the valleys themselves. It appears to me hard to see how a thoughtful survey can lead to any other conclusion than that "the mountains have been formed by the hollowing out of the valleys, and the valleys have been hollowed out by the attrition of hard materials coming from the mountains."

Did the reader ever stand on a flat shore and watch how the water, which had soaked into the sand just below the upper limit of the tide, trickled down the seaward slope towards the pools and shallows on the lower part of the beach? He could hardly find a better illustration of the drainage of a country. The water that oozes out from below high-tide mark begins by degrees to gather into tiny runnels, these gain size and speed as they descend, often flowing into each other, and thus with their united torrent cutting narrow and sometimes tortuous channels for themselves out of the sand. If the locality be a favourable one, these miniature rivers may be seen undermining their banks, and sweeping the *débris* away to sea. Thus the sand which wore, perhaps, a perfectly smooth surface when the tide left it a few hours before, is now channelled and worn into diminutive valleys, gorges, and ravines, with narrow ridges and broader plateaux between them. It might then be taken as a kind of relief model of the drainage of one side of a country. As the process of erosion goes on, the likeness of the beach to a series of river-systems grows every minute more marked. But at last the turned tide comes back and levels the whole; thus illustrating what geologists call "a plain of marine denudation." Yet again this levelled surface,

when the tide retires, is once more exposed, the same system of water-carving goes on as before, and a new system of valleys, ravines, water-courses, ridges, and table-lands makes its appearance.

Now it is, I believe, in this kind of way that a great river-system is excavated. The process is then, of course, an infinitely longer one, calling in, as we shall see, the agency of rain, springs, streams, and ice, and making these all work together for the accomplishment of the general end; but in either case the ultimate result is achieved by denudation. Water seeking its way seaward cuts a net-work of paths for itself: an hour or so is enough to channel the sandy beach, millions of years may be needed to cut down a mass of high ground into mountain and glen; but in the long lapse of geological time the one result is, doubtless, as sure as the other.

The conclusion, therefore, to which an attentive examination of the present surface of the country points is, that although the rocks have unquestionably suffered much from subterranean commotion, it is not to that cause that their present external forms are chiefly to be traced; that the mountains exist, not because they have been upheaved as such above the valleys, but because their flanks having been deeply cut away they have been left standing out in relief; and that the valleys are there, not by virtue of old rents and subsidences, but because moving water, with its help-mates frost and ice, has carved them out of the solid rock.—*Abridged from* GEIKIE's *Scenery of Scotland.*

THE SALT MINES OF WIELICZKA.

You have probably heard of the celebrated salt mines of Wieliczka in Poland, the description of which has been greatly exaggerated by the generality of travellers; but Mr. Brard, whose account of them is much more faithful, and agrees exactly with that of Townson, describes them thus: "The workings in these mines consist of three stories, each of which corresponds to a bed or stratum of salt. The first of these workings is at 200

feet below the surface, and the third and lowest at a depth of 740 feet—some travellers have said 1000. The salt at this deepest working is the purest, and no other is at present extracted. This working extends over a distance of nearly half a league in length, and almost a quarter of a league in breadth. It consists of galleries and chambers of great height, wholly excavated out of the salt; the roof being supported, where necessary, by pillars of this substance, left for the purpose. Some of these chambers are said to be from 180 to 300 feet high." The salt is extracted by means of wedges and levers, and by blasting with gunpowder (perhaps now superseded by gun-cotton, of which you have no doubt read the accounts). From the huge masses thus detached, the purest is shaped upon the spot into cylinders three feet high, and two and a half in diameter; and these, under the name of *balwāns*, are exported, whereas the chippings are reserved for home consumption. Twelve shafts are kept open for the service of the mines; that is, for the extraction of the salt, and the passage up and down of the miners. The communication from the upper to the lower workings is effected by means of wooden stairs of easy descent. One of these flights of stairs is reserved for visitors of distinction.

These mines give employment to from twelve to fourteen hundred workmen and forty horses; which latter are employed in the interior of the mines, where they remain for six or seven years, without experiencing any other inconvenience than that of becoming totally blind. The air, which circulates freely in these vast caverns, is pure and dry; the miners enjoy robust health, and the wood-work remains sound for a very long time. These mines have been worked ever since the sixteenth century (Patrin says since 1251). They produce annually 150,000 hundred-weight of salt. Some travellers have asserted that there exists in the mine an entire village; and that the miners, with their families, pass their whole lives there without ever seeing the light of the sun, &c. The simple fact is this: There exists in the first or upper story a chapel, wholly sculptured out of the salt, and dedicated to St. Anthony. This chapel is 30 feet long,

by 24 in breadth, and 18 in height. The altar and steps, the candelabra and other ornaments, the twisted columns that sustain the roof, the pulpit, the crucifix, and the statues of the Virgin and of St. Anthony, are all sculptured in salt, as is also a statue of Sigismund, King of Poland. There are also two other chapels of a similar kind, in which Mass is performed to the sound of trumpets and cymbals on particular days of the year, in commemoration of certain phenomena which occurred in the mines in former times. Stables are constructed for the horses, and closets in which the workmen can lock up their tools when they come up from their work, which they do every day. There are in the mines several lakes, which may be navigated in boats; and close to a spring of salt water there is one of fresh water, of excellent quality, which is used for the horses. Upon the whole, and without any exaggeration, these mines have a magical and imposing aspect, from the vastness of the excavations, and the brilliancy of the walls and the roof, and of the pillars which support it. When they are visited by persons of distinction, the chapel, the galleries, and the vaulted roofs, are illuminated with innumerable torches, the light of which, refracted in all directions, produces an effect brilliant beyond description.—JACKSON: *Minerals and their Uses.*

DIAMOND-SEARCHING IN BRAZIL.

THE different kinds of soil through which it is necessary to cut before reaching the deposit in which the diamonds are found, are, in the first place, about twenty feet of a reddish sandy soil, which is loosened by the hoe, and then washed into the river by a current of water issuing from the small stream that serves to work the water-wheel. Below this are about eight feet of a tough yellowish clay, which is dug out by the hoe, and carried away on the heads of negroes in flat wooden bowls about a foot and a half in diameter, no such implement as a barrow being here. Beneath this clay occurs a layer of coarse reddish sand,

about two feet and a half in thickness; and then under this lies the peculiar deposit containing the diamonds. When this diamond formation consists of loose gravel, it is called *cascalho* in the language of the miners, and *canga* when found in the state of a ferruginous conglomerate. This bed varies from one to four feet in thickness, and the gravel of which it is composed consists of small pebbles of primitive rocks, which, from their rounded and polished nature, have evidently at some distant period been brought together by the force of running water. These pebbles are of various kinds, but when there appears much of what is called *esmeril preto*, a kind of tourmaline, the cascalho is considered to be rich in diamonds. The cascalho generally rests upon a substratum of hard clay called *pizarra*, beneath which are found the schistose rocks that prevail throughout the diamond district. Sometimes *canga*, or the agglutinated gravel, rests upon a kind of limestone; and when this occurs it is always found to be rich in diamonds.

The manner in which the washing of the cascalho is carried on is as follows:—Along one side of a pond of water is placed a range of eleven troughs, about three feet square, the side next to the water being much lower than the others. These troughs, the bottoms of which are made of closely-rammed clay, are called *bacós*, and into each of them a portion of cascalho is put by a slave stationed there for that purpose. In front of each bacó stands another slave up to his knees in water, having a large wooden plate (*bateia*), with which he dashes water upon the cascalho with considerable force. By this means, and by stirring it at frequent intervals with a small hoe, it is freed from the earth and sand with which it is mixed; the larger particles of gravel rise to the surface and are taken out; and it is during this process that the largest diamonds are usually found. Immediately in front of these troughs, and about three feet above the level of the ground separate seats are erected for two overseers, each armed with a long leathern whip, who keep a strict look-out that no diamonds are stolen. This labour is continued from morning till about four o'clock in the afternoon, when the cascalho thus

washed and purified is taken out of the bacós, and carried to the side of a little stream to be finally washed and inspected.

On accompanying the captain to witness the performance of this operation, which to the stranger is the most interesting process in diamond-mining, I found seven slaves seated on the side of a small canal about four feet broad, with their legs in the water nearly up to their knees. This little stream is called the *lavadeira*. Each of the slaves had a large flat wooden plate, similar to that used in washing the rough cascalho, into which a small shovelful of the purified cascalho was put by a slave stationed behind the others for that purpose. This done, the washer filled the bateia with water, and whirling it round in a peculiar manner on the surface of the stream, the larger gravel rose to the top, and was carefully examined. This being repeated several times, he then placed the bateia on his knees, the right knee being considerably lower than the left, when with his hand he threw water on the fine gravel, which was thus washed out with great care into the canal until the bateia was empty. It is in this last process that diamonds are expected to be found. A small bateia containing a little water, was placed on a low pedestal between the two overseers, and into this the diamonds were put as they were found, which on this occasion amounted to eleven; all of which, however, were small. In the bottom of the bateias is always found a small quantity of gold-dust, which is carefully preserved.

Although diamonds are usually found in the diluvial gravelly soil above described, that, however, is not the matrix in which they have originally been formed. Whatever may be the case in other countries, I am perfectly satisfied that here they have originally been formed in the metamorphic schistose rock of which the mountains in the diamond district are composed, and that they have during a long series of years been washed down along with the other *débris*, to the place where they are now found so abundantly. These rocks are rather soft in their nature, and, of course, easily disintegrated; hence the many wild ravines that intersect this range, excavated by the streams that flow from it. Fragments of the rock have frequently been found with

diamonds imbedded in them. In the Cidade Diamantino I saw two beautiful specimens, in each of which one-half of a small diamond was exposed; but the extravagant price asked for them prevented me from purchasing.—GARDNER: *Travels in the Interior of Brazil.*

THE HOT SPRINGS OF ICELAND.

THE hot springs of Iceland may be arranged under four heads:—1. The Great Geyser, the Little Geyser, and the Strokr, which throw up at intervals a column of steam and water to a great height, and with a loud report before and during the eruption. 2. Springs continually boiling with a loud hissing noise, but which never overflow their boundaries. 3. Pools of clear, smooth water, boiling hot, whose surface is never ruffled by any internal disturbance, but which continually flows off by some outlet. And, 4. Mud springs.

The Great Geyser (*Geyser*, an Icelandic word signifying "roarer" or "rager") rises out of a low mount, gradually increasing in height as the deposit is formed, at the extreme north end of the hill. The ground falls away immediately behind it to the west and north, where a chasm about forty feet in depth has been hollowed out by a rivulet which runs down to join the river which flows past the hill to the east. The mount is entirely formed by, or coated with, the silicious or flinty deposit of the spring. It lies either in patches like the head of a cauliflower—of a substance much resembling brain-coral, in colour of a dull gray, due probably to the great admixture of silica—or, where water is continually flowing over it, in thin level plates. When the spring overflows, the water escapes down the chasm to the west, or else in several rills in an opposite direction, which finally find their way to the river. Wherever it flows its high temperature destroys vegetation entirely. The grass which comes up close to the foot of the Geyser on the north is growing on older deposits, which have gradually become coated with mould. The basin of the Great Geyser measures 46 feet by 55 feet 8 inches. It was, unfortunately, always

full while I was there, so that I had no opportunity of measuring the pipe, which descends vertically at the centre of the basin to the depth, as I understand, of 90 feet. The basin slopes very gradually to the edge of the pipe. The mound is about 30 feet above the level of the spot on which we pitched our tent. The eruptions are quite irregular. It boils over eight or nine times in twenty-four hours. The Icelanders believe the eruptions to be more frequent in wet than in dry weather. The only eruption I saw was in heavy rain, which had lasted six hours, and the length of the column might have been from 60 to 80 feet.

The Little Geyser is surrounded by a circular mass of deposit, 19 feet in diameter, like that of the Great Geyser, only more flattened. It appears to rest on older deposit, but as the whole hill for a quarter of a mile southward from the Great Geyser consists of nothing but deposits (silicious sinter) of various ages, perforated by springs, which seem to change their position not unfrequently, it becomes extremely difficult to determine the age of any one portion. The mouth of the Little Geyser is 2 feet in diameter, becoming narrower as it deepens. Its sides are coated with deposits. The pipe is 12 feet in depth, and the water is 1 foot from the surface of the ground. The eruptions seem to be more frequent than those of the Great Geyser, are not announced by any previous rumbling, and throw up a very small volume of water compared with the great quantity of steam.

Strokr ("the Churn") is at the bottom of a shallow saucer, having a radius of 30 feet or thereby. It is coated with deposit lying in a direction parallel to the inclination of the basin. Close round the pipe, extending to a distance of 4 or 5 feet from it, are five rings of a different deposit, standing vertically. The pipe, 8 feet in diameter and 43 in depth, is a roaring gullet, coated with red incrustations. On looking down, the water can just be seen boiling and fluttering. It erupts occasionally, and may be made to do so in three or four minutes at pleasure by throwing in a sufficient quantity of turf and clods.

Of the second class of springs there are several. In some the boiling water is visible in a shallow saucer; in others it can only

be heard down in a deep pipe: in some, again, it makes its presence known by a continuous effusion of steam; while in others there is a continuous hissing, but no steam or water visible.

We now come to the still pools. The one near the Great Geyser is by far the most beautiful of all the springs. It is in two divisions, which apparently join beneath under a natural bridge, and is brimful of very hot water of the loveliest blue imaginable, through which one sees the incrustations down its sides to a considerable depth. Its depth is upwards of 17 feet at the northern end and nearly 24 feet at the southern. From it descends a copious stream, which deposits as it flows level layers of an orange-coloured incrustation, worn as smooth as polished marble by the action of the water. There are five more pools close behind the Little Geyser, but these are by no means so beautiful. They overflow constantly in numerous streams, which run down the hill towards the river, but lose themselves among the grass before reaching it. Among these are some bubbling fountains, which go up every now and then with a spirt, but do not eject water beyond their margins. The arrangement of the deposit of these pools varies: in most of them it is smooth, or only slightly arched, but in one near the Little Geyser it is ribbed and rippled in a very beautiful manner.

The mud springs are very few. There are some in the cluster of springs between Strokr and the Little Geyser, and two or three on the bank above the Great Geyser. The mud always preserves the same level. Moss and grass grow at their edges.

There is everywhere abundant evidence of changes that have taken place in the springs. Some have ceased to be so active as heretofore, some at present emit only steam, while others have become wholly inactive, and their openings are fast filling up.—J. W. Clark: *Notes of Travel in* 1860.

MORAINES.

This is the name given in Switzerland to the longitudinal mounds of stony *detritus* which occur at the bases and along the edges

of all the great glaciers. The formation and nature of these accumulations have thus been graphically described by Professor Tyndall in his "Glaciers of the Alps:"—"The surface of the glacier does not long retain the shining whiteness of the snow from which it is derived. It is flanked by mountains which are washed by rain, dislocated by frost, riven by lightning, traversed by avalanches, and swept by storms. The lighter débris is scattered by the winds far and wide over the glacier, sullying the purity of its surface. Loose shingle rattles at intervals down the sides of the mountains, and falls upon the ice where it touches the rocks. Large blocks are continually let loose, which come jumping from ledge to ledge; the cohesion of some being proof against the shocks which they experience, while others, when they hit the rocks, burst like bomb-shells, and shower their fragments upon the ice.

"Thus the glacier is incessantly loaded along its borders with the ruins of the mountains which limit it; and it is evident the quantity of rock and rubbish thus cast upon the glacier depends upon the character of the adjacent mountains. Where the summits are bare and friable, we may expect copious showers; where they are resistant, and particularly where they are protected by a covering of ice and snow, the quantity will be small. As the glacier moves downward, it carries with it the load deposited upon it. Long ridges of débris thus flank the glacier, and these ridges are called *lateral moraines*. Where two tributary glaciers join to form a trunk-glacier, their adjacent lateral moraines are laid side by side at the place of confluence, thus constituting a ridge which runs along the middle of the trunk-glacier, and which is called a *medial moraine*. The rocks and débris carried down by the glacier are finally deposited (when it melts away) at its lower extremity, forming there a *terminal moraine*.

"It need hardly be stated that the number of medial moraines is only limited by the number of branch glaciers. If a glacier have but two branches, it will only have one medial moraine; if it have three branches, it will have two medial moraines; in short, the number of medial moraines is always *one less* than the

number of branches. When a glacier diminishes in size, it leaves its lateral moraines stranded on the flanks of the valleys. Successive shrinkings may thus occur, and have occurred at intervals of centuries, and a succession of old lateral moraines, such as many glacier-valleys exhibit, is the consequence. The Mer de Glace (one of the great Alpine glaciers), for example, has its old lateral moraines, which run parallel with its present ones. The glacier may also diminish *in length* at distant intervals, the result being a succession of more or less concentric terminal moraines. In front of the Rhone Glacier we have six or seven moraines, and the Mer de Glace also possesses a series of them. To this it may be added, that in all mountainous regions, which have formerly been the theatres of glacial phenomena, there occur in the glens long longitudinal spits or terraces of gravelly dêbris flanking their sides, and cross mounds barring their lower extremities; the former being the lateral, and the latter the terminal moraines of glaciers that once occupied these glens, as similar masses now fill the upper glens and gorges of Norway and Switzerland. To the geographer and geologist these flanking and barring mounds of miscellaneous dêbris are certain evidences of former ice-action, whether occurring among the mountains of Wales and the Scottish Highlands or along the lower valleys of the Alps and Dofrafelds."

THE MEDANOS OR SAND-DUNES OF PERU.

ON dry sandy tracts "sand-pillars" driven by the wind, and "sand-dunes" aggregated in grotesque and irregular forms, are common phenomena. Those in the arid region of the Peruvian seaboard are thus described by Dr. Von Tschudi in his instructive Travels in that historically and geographically interesting country:—"From 3° 35′ to 21° 48′ S. latitude, a plain of sand, 540 leagues long, and varying from 3 to 20 leagues in breadth, stretches along the coast of the Pacific Ocean. It is intersected by chains of small hillocks, which, extending westward from the Cordilleras, gradually diminish in height, and

either become blended with the plain or form abrupt promontories which project into the sea. Between the river Loa, which marks the southern frontier of the Peruvian coast, and the Tumbez on the northern boundary, fifty-nine streams, great and small, pass through the line of coast. Proceeding from the avalanches of the Andes or from the small Alpine lakes, they force their way through narrow mountain-valleys, irrigate the waste grounds, and then, after a brief course, flow into the great ocean.

A fine, light, yellow, drift-sand covers hill and dale. It is only where rivers intersect the plain that oases of luxuriant vegetation are formed. The peril of traversing these plains is greatly increased by the movability of the sand and the *medānos*. The strong winds raise immense clouds of dust and sand. The sand rises in columns of from eighty to one hundred feet high, which whirl about in all directions, as if moved by magic. Sometimes they suddenly overshadow the traveller, who only escapes from them by rapid riding. The medanos are hillock-like elevations of sand, some having a firm, others a loose base. The former, which are always crescent-shaped, are from ten to twenty feet high, and have an acute crest. The inner side is perpendicular, and the outer or bow side forms an angle with a steep inclination downwards. When driven by violent winds, the medanos pass rapidly over the plains. The smaller and lighter ones move quickly forward before the larger ones; but the latter soon overtake and crush them, whilst they are themselves shivered by the collision. These medanos assume all sorts of extraordinary figures, and sometimes move along the plain in rows forming most intricate labyrinths, whereby what might otherwise be visible in the distance is concealed from the view of the traveller. A plain often appears to be covered with a row of medanos, and some days afterwards it is again restored to its level and uniform aspect. Persons who have the greatest experience of the coast are apt to mistake their way, when they encounter these sand-hills.

The medanos with immovable bases are formed on the blocks of rock which are scattered about the plain. The sand is driven

against them by the wind, and as soon as it reaches the top point it descends on the other side until that is likewise covered. Thus gradually arises a conical-formed hill. Entire hillock-chains with acute crests are formed in a similar manner. The small hillock-chain, by which the coast is intersected obliquely from east to west, is a boundary which arrests the progress of the wandering medanos; otherwise fruitful oases would soon be converted into barren sand-flats. A correct observation of these hillock-chains affords a most certain index to the direction of the prevailing winds. On their southern declivities are found vast masses of sand drifted thither by the mid-day gales. The northern declivity, though not steeper than the southern, is only sparingly covered with sand. These movements and new formations in the deserts are only in full activity during the hot season; for then the parched sand yields to the slightest pressure of the atmosphere. In the cold season its weight increases by absorption of humidity. The particles unite in masses and more easily resist the wind. In the meantime the hillocks also acquire more firmness by the increased weight which presses on them from above.

THE KJÖKKENMODDING OR SHELL-MOUNDS OF DENMARK.

THE word Kjökkenmödding is derived from *kjökken* a kitchen, and *mödding* a refuse-heap; the word "midding" still being used in this sense in the north of England. The kjökkenmöddings, as their name implies, consist of heaps of shells and bones, which after being picked clean by the savage tribes who in ancient times dwelt upon the coast, were tossed away in a common heap as useless rubbish. At first these shell-mounds were supposed to be raised beaches or old shore-lines, like those that occur on various parts of the British coasts. They are, however, entirely free from earth, gravel, or sand—inorganic materials of which a sea-shore always consists. It is evident, therefore, that they cannot have been thrown up by the waves. Another very

significant fact is this, that the shells found in them are almost invariably full-grown specimens, and, moreover, consist of four species which dwell at different depths in the water, and are of widely different habits, resembling each other only in this particular, that they have in all ages been selected by man as his food.

Any one of these facts would have sufficiently proved that the Danish shell-mounds were not natural phenomena; but the discovery in them of numerous rude flint weapons and implements, bones evidently shaped for use, and pieces of charred wood and brown broken pottery, set all doubts on this point at rest. The shell-heaps, then, are evidently accumulations round the dwellings of some ancient inhabitants of Denmark; and in them, as in a book, we may read a small portion of the history of the past. If we were to examine a refuse-heap of the present day, we should find in it—not, of course, the more costly and valuable articles now in use—but pieces of our commoner vessels and utensils, which would give some clew to the habits and condition of those by whom they were employed. Just so it is with regard to these Danish kjökkenmöddings. Probably at that period many persons possessed weapons and implements more elaborate than those of which we find the fragments; but at anyrate we know what were the commoner and less valued forms, and can thus gain some approximate idea of the civilization attained by their owners.

Much interest was excited in Denmark by the discovery of these ancient refuse-heaps, and a committee of antiquaries was formed, in order that the matter might be thoroughly investigated. More than fifty kjökkenmöddings have been discovered and examined more or less carefully, and many thousand specimens of bones and of bone and flint implements have been collected. Separate memoirs on the subject have been written by Professors Steenstrup and Worsaæ, and the general results have been embodied in six Reports made to the Academy of Sciences at Copenhagen. From these it appears that the shell-mounds are for the most part situated near the coast, and in places

where savages living in this primitive manner, chiefly on shell-fish, could obtain a ready supply. Few of them are found inland, and where this happens, it indicates a recent change in the coast-line of the country. Another curious evidence respecting such changes in the distribution of land and water is, that the shells discovered in the kjökkenmöddings are all large and strong specimens, while at the present day some of them are quite extinct in the same localities, and some much diversified and stunted by the brackishness of the water. The four species found most abundantly in the shell-heaps are the oyster, cockle, mussel, and periwinkle. Fish bones are exceedingly numerous, being chiefly those of the herring, flounder, dorse, and eel. A few fragments only of crustacea (crab-family) have been found. Of birds, water-fowl appear to have been most commonly used. Remains of the domestic fowl, sparrows, storks, and the like, are altogether absent; but two very interesting species, no longer inhabiting Denmark, have been discovered—namely, the Capercailzie and the Great Auk. The pine, on the buds of which the capercailzie feeds, no longer grows in Denmark; but we know, from the remains of it found in peat bogs, that it was at one time abundant there, and therefore to this period those refuse-heaps may be very probably referred. The remains of mammalia have been most carefully studied by Professor Steenstrup, and it is remarkable that he finds no trace of any domestic animal except the dog. The most common species are the stag, the roe, and the wild boar. No trace of horse or sheep has yet been found, and though remains of the ox have been discovered, these are referred by the Professor to a wild species.

That these shell-heaps are very old, is evident from the articles found in them, from the absence of domestic animals and of all trace of metal, from the change in the geographical distribution of land and sea, and from the alteration in the fauna or animal-life of the country.—MRS. LUBBOCK : *Notes of Travel in* 1862–3. [Since Mrs. Lubbock wrote the above, similar shell-mounds have been discovered along other continental shores, as well as

along the coasts of our own islands; and, in every instance, the species of shells, the fragments of bone, the bone and stone implements, &c., point to similar conditions of savage life and to a period long antecedent to either history or tradition.]

GUANO: ITS NATURE AND ORIGIN.

OPPOSITE to Pisco and Chincha (on the Peruvian coast) there is a group of small islands, of which the largest is six English miles distant from Pisco. These islands have of late years become celebrated on account of the great quantity of guano that has been exported from them. Guano—a corruption of the Quichua or Peruvian word *huanu*—is found on these islands in enormous layers, from forty to eighty, or even, according to some, one hundred and twenty feet thick. The upper strata are of a grayish-brown colour, which lower down becomes darker. In the lower strata the colour is rusty red, as if tinged by oxide of iron. The guano becomes progressively more and more solid, from the surface downward—a circumstance naturally accounted for by the gradual deposit of the strata, and the evaporation of the fluid particles. Guano is found on all the islands, and on most of the uninhabited promontories of the west coasts of South America, especially in those parts within the tropics. It is formed of the excrements of different kinds of marine birds—as mews, divers, sheer-beaks, &c., and often contains their skeletons and eggs, as well as the decomposed bodies and bones of seals, and other marine creatures frequenting these islands.

The immense flocks of those birds, as they fly along the coast, appear like clouds. When their vast numbers, their extraordinary voracity, and the facility with which they procure their food, are considered, one cannot be surprised at the magnitude of the beds of guano, which have resulted from uninterrupted accumulations during many thousand years. I kept for some days a living sheer-beak, which I fed abundantly with fish. The average daily weight of the excrement was from three and a half to five ounces.

I have no doubt that when the birds are in a state of freedom the weight must be much greater; for they are constantly plunging into the sea in order to devour fishes, which they find in extraordinary abundance around all the islands. When an island is inhabited by millions of sea-birds, though two-thirds of the guano should be lost while flying, still a very considerable stratum would be accumulated in the course of a year. The marine birds nestle on the uninhabited islands, or on rocks near the shore; but they never settle on the flat beach, or on any place distant from it inland. During the first year of the deposit the strata are white, and the guano is then called *guano blanco.* In the opinion of the Peruvian cultivators, this is the most efficacious kind. As soon as the dealers begin to work one of the beds, the island on which it is formed is abandoned by the birds. It has also been remarked, that since the increase of trade and navigation they have withdrawn from the islands in the neighbourhood of the ports.

Much has been written on the employment and utility of guano, but the manner in which it is applied as manure in Peru seems to be little known. The Peruvians use it chiefly in the cultivation of maize and potatoes. A few weeks after the seeds begin to shoot, a little hollow is dug round each root and filled with guano, which is afterwards covered with a layer of earth. After the lapse of twelve or fifteen hours the whole field is laid under water, and is left in that state for some hours. Of the white guano a less quantity suffices, and the field must be more speedily and abundantly watered, otherwise the roots would be destroyed. The effect of this manure is incredibly rapid. In a few days the growth of a plant is doubled. If the manure be applied a second time, but in smaller quantity, a rich harvest is certain. At least, the produce will be threefold that which would have been obtained from the unmanured soil.

The employment of this kind of manure is very ancient in Peru, and there is authentic evidence of its having been used in the time of the Incas. The white guano was then chiefly found on the islands opposite to Chincha; so that for upwards of six hundred years the deposit has been progressively removed from

those islands without any apparent decrease of the accumulation. The uniformity of climate, on a coast where it seldom or never rains, must contribute to render the Peruvian guano a more arid manure than the African (the Ichaboe of commerce); as, fewer of the salts of the former being in solution, they are consequently less subject to evaporation.—TSCHUDI: *Travels in Peru.*

THE TIDE-WAVE IN THE BAY OF FUNDY: ITS GEOLOGICAL RESULTS.

THE tide-wave that sweeps to the north-east, along the Atlantic coast of the United States, entering the funnel-like mouth of the Bay of Fundy, becomes compressed and elevated as the sides of the bay gradually approach each other, until in the narrower parts the water runs at the rate of six or seven miles per hour, and the vertical rise of the tide amounts to sixty feet or more. In Cobequid and Chiegnecto Bays, these tides, to an unaccustomed spectator, have rather the aspect of some rare convulsion of nature than of an ordinary daily phenomenon. At low tide, wide flats of brown mud are seen to extend for miles, as if the sea had altogether retired from its bed; and the distant channel appears as a mere strip of muddy water. At the commencement of flood, a slight ripple is seen to break over the edge of the flats. It rushes swiftly forward, and, covering the lower flats almost instantaneously, gains rapidly on the higher swells of mud, which appear as if they were being dissolved in the turbid waters. At the same time the torrent of red water enters all the channels, creeks, and estuaries; surging, whirling, and foaming, and often having in its front a white, breaking wave, or "bore," which runs steadily forward, meeting and swallowing up the remains of the ebb still trickling down the channels. The mud flats are soon covered; and then, as the stranger sees the water gaining with noiseless and steady rapidity on the steep sides of banks and cliffs, a sense of insecurity creeps over him, as if no limit could be set to the advancing deluge. In a little time,

however, he sees that the fiat, "Hitherto shalt thou come, but no further," has been issued to the great bay tide: its retreat commences, and the waters rush back as rapidly as they entered.

The rising tide sweeps away the fine material from every exposed bank and cliff, and becomes loaded with mud and extremely fine sand, which, as it stagnates at high water, it deposits in a thin layer on the surface of the flats. This layer, which may vary in thickness from a quarter of an inch to a quarter of a line, is coarser and thicker at the outer edge of the flats than nearer the shore; and hence these flats, as well as the marshes, are usually higher near the channels than at their inner edge. From the same cause—the more rapid deposition of the coarser sediment—the lower side of the layer is arenaceous, and sometimes dotted over with films of mica, while the upper side is fine and slimy, and when dry has a shining and polished surface. The falling tide has little effect on these deposits, and hence the gradual growth of the flats, until they reach such a height that they can be overflowed only by the high spring tides. They then become natural or salt marsh, covered with the coarse grasses and *carices* which grow in such places. So far the process is carried on by the hand of Nature; and before the colonization of Nova Scotia, there were large tracts of this grassy alluvium to excite the wonder and delight of the first settlers on the shores of the Bay of Fundy. Man, however, carries the land-making process further; and by diking and draining, excludes the sea water, and produces a soil capable of yielding for an indefinite period, without manure, the most valuable cultivated grains and grasses. Already there are in Nova Scotia more than forty thousand acres of diked marsh, or "dike," as it is more shortly called, the average value of which cannot be estimated at less than twenty pounds currency per acre. The undiked flats, bare at low tide, are of immensely greater extent.

Much geological interest attaches to the marine alluvium of the Bay of Fundy, from the great breadth of it laid bare at low tide, and the facilities which it in consequence affords for the study of sun-cracks, impressions of rain-drops, footprints of

animals, and other appearances which we find imitated on many ancient rocks. The genuineness of these ancient traces, as well as their mode of preservation, can be illustrated and proved only by the study of modern deposits. I quote a summary of facts of this kind from a paper on rain-prints by Sir Charles Lyell, who was the first to direct attention to these phenomena as exhibited in the Bay of Fundy :—

"The sediment with which the waters are charged is extremely fine, being derived from the destruction of cliffs of red sandstone and shale, belonging chiefly to the coal measures. On the borders of even the smallest estuaries communicating with a bay, in which the tides rise sixty feet and upwards, large areas are laid dry for nearly a fortnight between the spring and neap tides, and the mud is then baked in summer by a hot sun, so that it becomes solidified and traversed by cracks caused by shrinkage. Portions of the hardened mud may then be taken up and removed without injury. On examining the edges of each slab, we observe numerous layers, formed by successive tides, usually very thin—sometimes only one-tenth of an inch thick; of unequal thickness, however, because, according to Dr. Webster, the night-tides, rising a foot higher than the day-tides, throw down more sediment. When a shower of rain falls, the highest portion of the mud-covered flat is usually too hard to receive any impressions; while that recently uncovered by the tide, near the water's edge, is too soft. Between these areas a zone occurs almost as smooth and even as a looking-glass, on which every drop forms a cavity of circular or oval form; and if the shower be transient, these pits retain their shape permanently, being dried by the sun, and being then too firm to be effaced by the action of the succeeding tide, which deposits upon them a new layer of mud. Hence we find on splitting open a slab an inch or more thick, on the upper surface of which the marks of recent rain occur, that an inferior layer, deposited perhaps ten or fourteen tides previously, exhibits on its under surface perfect casts of rain-prints which stand out in relief, the moulds of the same being seen in the layer below."

After mentioning that a continued shower of rain obliterates the more regular impressions, and produces merely a blistered or uneven surface, and describing minutely the characteristics of true rain-marks in their most perfect state, Sir Charles adds:—

"On some of the specimens the winding tubular tracks of worms are seen, which have been bored just beneath the surface. Sometimes the worms have dived beneath the surface, and then re-appeared. Occasionally the same mud is traversed by the foot-prints of birds (*Tringa minuta*, sand-piper), and of musk rats, minks, dogs, sheep, and cats. The leaves also of elm, maple, and oak trees have been scattered by the winds over the soft mud, and having been buried under the deposits of succeeding tides, are found on dividing the layers. When the leaves themselves are removed, very faithful impressions, not only of their outline, but of their minutest veins, are left imprinted on the clay."

We have here a perfect instance, in a modern deposit, of phenomena which we shall have to notice in some of the most ancient rocks; and it is only by such minute studies of existing nature that we can hope to interpret those older appearances. In some very ancient rocks we have impressions of rain-marks, or their casts, on the under surface of the overlying beds, quite similar to those which occur in the alluvial mud of the Bay of Fundy. In these old rocks, also, and especially in the coal formation, we find surfaces netted with sun-cracks precisely like those on the dried surfaces of the modern mud flats, and faithful casts of these taken by the beds next deposited. A still more curious appearance is presented by the rill-marks produced by the flowing of the receding tide, or of rain, down inclined surfaces of mud. The little streamlets flowing together into larger channels, form singular patterns, which may be compared to graceful foliage or to the ramifications of roots, and which have often been mistaken for fossils. . . . A still more striking geological fact connected with the marshes, is the presence beneath them of stumps of trees still rooted in the soil, and other indications which prove that much, if not the whole of this marine alluvium, rests on

what once was upland soil supporting forest trees; and that, by some change of level, these ancient forests have been submerged and buried under the tidal deposits.—*Abridged from* DAWSON's *Acadian Geology*.

HOW LAKES DISAPPEAR.

LET us briefly trace the process (for it is an instructive one) by which old lakes have been obliterated, and by which every existing lake is steadily tending to obliteration. Wherever there is an entering stream or runnel, there sand, mud, and miscellaneous débris are sure to be accumulated. Clear as the running stream may appear in summer, there are times—after sudden and heavy rain-falls, the melting of the upland snows in spring, and the like—when the current is discoloured and laden with earthy impurities. When the stream comes to rest in the lake, these impurities fall to the bottom—gravel, sand, and mud, according to their respective gravities; and thus, year after year and century after century, the lake becomes shallower and shallower, till at last it is converted into alluvial meadow-land. And as the waters become shallower, this silting process is greatly facilitated by the growth of reeds, bulrushes, equisetums, and other aquatic plants, which spring up on the little deltas, and act as so many sieves and screens to intercept and entangle the stream-borne débris. But not only do these plants intercept the floating impurities; their own annual growth and decay are incessantly adding to the accumulation, and in a few generations the reedy mire is converted into the rushy meadow. In this way the little deltas are continually encroaching on the lake, while its central parts are also receiving more or less of impalpable sediment, or are the nursing-grounds of myriads of aquatic molluscs—*lymnæa*, *paludina*, *planorbis*, &c.—whose shells, generation after generation, accumulate in limy layers of marl, which further tend to the shoaling of the waters. And while stream and vegetable and animal growth are thus gradually filling up the lake, its waters are further diminished by the auxiliary process of the out-flowing

stream, which is as persistently and incessantly deepening its channel, and more and more draining its parent supply.

By this double process of silting and draining, the lake becomes gradually shallower and shallower, till at length what was formerly a sheet of rippling water assumes the character of a stagnant mire, with here and there a pool of dark and deeper water, caused by some hidden spring beneath, or by the operations of the marl-dredger. In process of time the reedy mire is converted by plant-growth into the grassy marsh or meadow; and at last man steps in and completes the process of extinction by his drains and ditches. The lake is gone; the haunt of coot and mallard has disappeared; no more will the peasant ply his line for perch or pike, nor sportsman float his punt in quest of wild-fowl. But though extinguished, it has left the record of its history; and in these layers of silt, and sand, and marl, and peat-earth through which the drainer cuts his way, we find the whole tale of its length, and breadth, and depth; the life it nourished, and in many instances indications of the animals that frequented its shores, and of the people who successively dwelt on or crossed over its waters.—PAGE: *Chips and Chapters.*

GEYSERS, HOT SPRINGS, AND LAKES.

THERE is a close connection between mud volcanoes and those intermittent boiling springs named Geysers (Icelandic, *ragers* or *roarers*). A good many of the mud volcanoes throw out jets of boiling water along with the mud; but in the case of the geysers the boiling water is ejected alone, without any visible impregnation. Nevertheless it for the most part contains some mineral substance in solution, be it silica, carbonate of lime, or sulphur.

The largest and best known geysers in the world are those of Iceland—the Great Geyser, in particular, having a most imposing appearance. Silica is the mineral with which the waters of this fountain are impregnated; and the substance which they deposit, as they slowly evaporate, is named siliceous sinter. This material

is what composes the mound, of six or seven feet in height, on which the spring is situated. On the top of the mound is a large oval basin, about three feet in depth, measuring in its larger diameter about fifty-six, and in its shorter about forty-six feet. The centre of this basin is occupied by a circular well about ten feet in diameter, and, so far as ascertained, between seventy and eighty feet deep.

It is out of the central well that the jet of boiling water springs, at intervals of six or seven hours. When the fountain is at rest, both the basin and the well appear quite empty; nor is there even any steam to be seen rising out of the latter. On the approach of the moment for action, the water rises in the well till it flows over into the basin. Then loud subterranean explosions are heard, and the ground all around is violently shaken. Instantly, and with immense force, up springs the jet of boiling water, of the full width of the well, and ascending to a great height in the air. The top of this lofty column of water is enveloped in clouds of steam, which diffuse themselves through the air, rendering it misty. The jets succeed each other with great rapidity to the number of sixteen or eighteen, the fountain remaining thus in play for only about five minutes at a time. The last of the jets thrown up generally ascends to the greatest height—usually to about one hundred, but sometimes to about one hundred and fifty feet, while on one occasion it was ascertained to have risen to the amazing height of two hundred and twelve feet. This great column having been ejected, the water sinks down into the well, and all that had filled the basin retires rapidly down the same channel; so that both basin and well become empty as before, and thus remain till the arrival of the time for the next eruption, when the same phenomena are repeated. It has been found that, by throwing large stones into the well, the period of the eruption may be hastened, while the loudness of the explosions and the violence of the action of the fountain are at the same time increased. The stones are thrown out with great force along with the water.

There have recently been discovered in California a set of

geysers much resembling those of Iceland, yet differing from them in certain particulars. Their waters are impregnated, not with silica, but with sulphur; and they thus approach more nearly in their character to mud volcanoes, whose ejections are, in like manner, much impregnated with that combustible. They are also, like them, collected in groups—there being no less than one hundred openings within a space of flat ground a mile square. Owing to their number and proximity, their individual energy is nothing like so violent as that of the geysers of Iceland. Their jets seldom rise higher than twenty or thirty feet; but so great a number playing within so confined a space produces an imposing effect. The jets of boiling water issue with a loud noise from little conical mounds, around which the ground is merely a crust of sulphur, like that in the Poison-crater of Tangkuban-Prahu in Java. When this crust is penetrated, the boiling water may be seen underneath. The rocks in the neighbourhood of these fountains are all corroded by the action of the sulphurous vapours. Nevertheless, within a distance of not more than fifty feet from them, trees grow without injury to their health.

There are some fountains of boiling water which, instead of being intermittent and throwing up jets at intervals, allow the liquid to flow from them in a perpetual stream. The most remarkable example of this sort occurs at a place called Roto Mahana in New Zealand. There is here a lake of considerable dimensions, whose waters are maintained nearly at the boiling point by the continual accession of boiling water from numerous springs. The most abundant of those sources is situated at the height of about one hundred feet above the level of the lake. It keeps an oval basin about two hundred and fifty feet in circumference continually full, the margins of which are fringed all round with pure white calcareous sinter, formed by deposits of the carbonate of lime, with which the hot water is impregnated. At various stages below the principal spring are several others, that contribute to feed the lake at the bottom, in the centre of which is a small island. Small bubbles continually escape from the surface of the water with a hissing sound, and the sand all round

the lake is at a high temperature. If a stick be thrust into it, very hot vapours will ascend from the hole. Not far from this lake there are several small basins filled with tepid water, which is very clear, and of a blue colour.

All the central parts, indeed, of the northern island of the New Zealand group are of a highly volcanic character. There is here a mountain named Tongariro, on whose snow-clad summit is a deep crater, from which volcanic vapours are still seen to issue, and which exhibits other indications of having been in a state of greater activity at a not very remote period of time. There is also, at no great distance from this mountain, a region containing numerous funnel-shaped chasms, emitting hot water, or steam, or sulphurous vapours, or boiling mud.

Hot springs are numerous in all quarters of the globe, especially in the neighbourhood of active or extinct volcanoes. Few, however, are so abundant and at so high a temperature as are those of Roto Mahana. As respects temperature, those next highest in the scale are the hot springs of Comangillas, near Guanaxuato in Mexico; and of Trincheras, between Porto Cabello and New Valentia on the coast of Venezuela. Both these springs have a temperature a little over 206° Fahr. The heat of by far the larger number is much below this point. It depends in a great measure on the depth from which the waters ascend—the deeper the hotter. This arises from their proximity at great depths to reservoirs of molten lava and highly heated strata, which, by converting into steam the water that percolates down to them, provide an agency for forcing the water to the surface, and at the same time for supplying it with its increased amount of heat. That some thermal springs are very deep-seated, and are connected with subterranean volcanic forces, is proved by the remarkable effects produced upon the springs at Töplitz in Bohemia during the great earthquake of Lisbon. Instances also of the origination of hot springs, or of their being altered in temperature, or stopped altogether, have been noticed in connection with both earthquakes and volcanoes.—PONTON'S *Earthquakes and Volcanoes.*

THE CHESIL BANK.

The Chesil Bank is, perhaps, one of the most astonishing formations in England;—not because it is wholly unique in character, for there are somewhat similar banks in other places, but because of its immense size and extent; besides which it has some most remarkable peculiarities in its formation, which, so far as we are aware, *are* unique. Visitors to Weymouth and Portland can hardly have failed to be struck with its remarkable appearance, as it joins the Isle of Portland to the mainland. It is an enormous mass of shingle, extending for seventeen miles, from its origin at Bridport to its abrupt termination against the cliffs of Portland. For about two miles of its extent from the former place, until it reaches the end of the cliffs, it is thrown, like other banks, against them; but at this point it gradually rises in height, and for the rest of its length has the appearance of an immense and exceedingly well-formed railway embankment. From its origin, for seven miles, until it reaches Abbotsbury, it is joined to the mainland, though rising high above it—its dimensions there being five hundred feet wide, and about twenty-five feet high. From Abbotsbury to Portland it still gradually increases in size, and at Portland it is six hundred feet wide, and forty feet high; but for the extent of this portion of ten miles it leaves the land, and is thrown up, as it were, *in* the sea; while between it and the land is a long estuary called the Fleet, communicating with the sea at Portland. Hence the appearance of the Chesil Bank, as seen from an elevated point, such as St. Catherine's Hill at Abbotsbury, is truly astonishing. It is like an immense *railway in the sea*, and it curves with a gentle and perfectly regular course from north-west to south-east, until it strikes land at Portland. Its formation in the sea is due to the existence of a submarine bed of Kimeridge clay, which forms a kind of shelf on which the shingle is piled up by the waves. On the land-side of the Fleet, which is about a mile wide, are seen the remains of the old cliffs and coastline, which probably existed before the Bank was formed. The

sides of the Bank are very steep, and consequently the sea breaks on it with great violence, making it a dangerous coast for shipping.

It would appear as if the Chesil Bank must have been in former times of less bulk than it is at present, for there is an account given us, in an old Saxon Chronicle of 1099, of a heavy sea that broke over the Bank, and flooded the fields on the other side. Leland also, writing in 1546, and Camden in 1590, speak of it as being broken away by seas washing over it during south-west gales; whereas at present no storms, however violent, appear to have very much permanent effect on it. The latest record of a very severe storm is that of November 1824, when a great quantity of the shingle was thrown on to the land-side; and a curious circumstance is recorded of a sloop, which was driven on the Bank, and actually carried by the violence of the waves to its summit, where the crew appear to have coolly disembarked, and walked into Weymouth. Next day they drew her down on the other side into the Fleet, and so sailed *round* Portland. But although even the most violent storms hardly affect the Chesil Bank, except by carrying away shingle, which is soon replaced by the sea, yet this very operation is accompanied by two remarkable phenomena. The first may be observed by any one who happens to be on the land-side at the time. If near the Bank, he will find himself enveloped in a perfect *shower* of shingle; so that, in the event of a shipwreck on the Bank, it is almost impossible to venture to the relief of the stranded crew. The other phenomenon consists in the *blowing up* of the Bank at various parts. Any one who travels along the land-side will be at once struck by a long succession of depressions or gullies in its side; in fact the land-side of the Bank has, at intervals, just the appearance of having been *quarried* for shingle—as if cart-loads of stones had been removed here and there to mend roads. This curious result arises from percolation of water through the mass of the Bank, whereby, in great storms, an immense pressure is brought to bear on the weakest portions, and suddenly such a portion will blow up, carrying hundreds of tons of shingle to the land-side.

Perhaps one of the most curious circumstances connected with this astonishing mass of shingle is the variation in the size of its pebbles. Any person who should travel along it from west to east, from Bridport to Portland, could not fail to be struck with the beautifully gradual increase in the size of the component pebbles of the Bank. Where the Bank commences, near Bridport harbour, it consists of small pebbles of the size of a pea, mixed with sand from the Burton Cliffs. These pebbles increase in size as we travel along the Bank, and at Abbotsbury they have attained the general size of large beans; while on arriving at the end at Portland, they will be found to be as large as apples, and many even much larger. This variation in size of the pebbles is the cause of the curious change in the noise of the waves, which strikes our ear immediately—on comparing their sound at Abbotsbury, for instance, with that at Portland. At the former place the sound made by the waves is of a *hissing* character, while at Portland it is a loud and prolonged *roar*. This change, though apparent, and even striking to any ear at all times, is wonderfully increased during a heavy gale of wind. We have never anywhere else heard the same peculiar, deafening roar, that we hear at Portland in a storm, when the immense Bank is overwhelmed by breakers, and, on account of its steepness towards the sea, each wave breaks upon it almost at right angles to its surface. This, aided by the size and hardness of the stones at this point, produces a sound peculiarly harsh and grating.

Now, as to the *cause* of this wonderful phenomenon. All the pebbles are brought by the tidal-wave and by storm-waves from the coast to the west between Exmouth and Lyme-Regis. Hence it is remarkable that the *largest* pebbles are carried *furthest!* Apparently, two separate causes tend to produce this result. First, we must remember that the strongest currents during the usual south-west winds will act more effectively out at sea, or towards Portland, than near the middle of the bay at Bridport, and will consequently carry the largest pebbles to Portland, while the smallest remain thrown up at Bridport. Secondly, if we remember that, in comparing the force of the waves upon

large and small pebbles, the larger ones will gain most in momentum, while the smaller have a proportionally larger surface to be acted upon, it will appear that the large pebbles will be carried *furthest* by violent waves, while the smaller will be carried *highest*, and will therefore *soonest* be thrown up out of the reach of any further action of the sea. All calcareous and easily worn pebbles are soon reduced to sand, and pass round Portland, so that the Bank consists of only the hardest kinds of stones, such as flint, jasper, &c. And, in consequence of the relative action just mentioned, it will be found that, while the small pebbles at Bridport and Abbotsbury are globular, the larger ones near Portland, in consequence of their being most exposed on the surface to the waves, are generally flat—a peculiarity noticed also at the coast near Budleigh, from which most of these pebbles are derived.

And this brings us to another curious thing about this Chesil Bank—namely, the source from which the immense mass of stones is derived. Mr. Coode, the engineer of the Breakwater, has written a small pamphlet on the subject, and by comparing his account with our own observations, we are led to assign the pebbles to the following classes: (1.) The great majority of the stones are evidently chalk flints and flints from the green-sand, which caps most of the hills between Exeter and Weymouth. On the Chesil Bank there are vast numbers of these flints, easily distinguishable; the chalk flints by their dark colour, and often by adhering silicate of lime; the green-sand flints by their lighter colour, and particles of sand embedded in them. (2.) A good many of the pebbles of the Chesil Bank are composed of red sandstone, generally marked by various spots of red, brown, and yellow. These can be traced to their source at Budleigh-Salterton, where they occur on the beach in company with (3.) jasper pebbles; which are all brought down by the river Otter from Aylesbeare and other hills in the interior of the district. (4.) We have also a certain proportion of green and red porphyritic pebbles, such as those which occur in the conglomerate cliffs of Torbay and Dawlish, but which are not thence derived, coming,

as they do, from the Heavitree conglomerate, near Exeter. In no instance that we have been able to make out have we any class of pebbles derived from any point west of Exeter. For example, we find no chlorite from the Start Point—no serpentine from the Lizard—all are derived from cliffs or hills between Exeter and Bridport; and of many cliffs even here no pebbles exist, being, in the cases of the softer strata, soon worn to sand, and so carried round Portland.

Such is a brief account of the chief features of the Chesil Bank. As we have said, its great peculiarities are its enormous mass, and its being formed by and passing through the sea, separate from the land. It has a very beautiful outline when seen from the summit of the Cliff at Portland, or viewed as an embankment from the level at Chesilton. It surpasses all other shingle-banks with which we are acquainted, which are, for the most part, merely bars at the mouths of rivers, or enclosing fresh-water lakes, as at Helstone and Slapton. That of Hurst Castle, at the mouth of the Solent, and opposite Yarmouth, is the only example, but on a smaller scale (so far as we know), of a true sea-bank formed on a submarine ledge or shelf of clay, and rising gradually in size from west to east, and deriving all its component pebbles from the double action of tidal-currents and storm-breakers.—*Abridged from* Chambers's *Journal.*

CORAL ISLANDS.

Strange as it may at first sight appear, there is an intimate connection between submarine volcanic action and the formation of coral islands in the Pacific.

The coral is a minute polyp, discernible only under the higher powers of the microscope. There are numerous species; but all of them are endowed with a power, which seems to reside in their skin, of separating lime from water holding it in solution, and so forming for themselves a hard crust of the carbonate of lime mixed with a little animal matter. This crust, which differs

much in form and appearance in the diverse species, serves the polyp for a habitation, and for a protection to its soft body.

Like other polyps, the coral grows by putting forth buds, much in the same manner as a tree. These buds grow close together, so as to form a large mass termed a *polypidom* (Lat. *polypus*, and *domus*, a dwelling), each chamber in which communicates with all the rest. The polypidoms, like the cells composing them, vary greatly in shape and aspect in the different species of coral. After a while the older polyps die, their cells become obliterated, and the coral stem acquires additional hardness. In this manner large beds, or *reefs*, are formed of the diverse species under the sea, where the water is not of too great a depth.

Coral reefs abound in the Red Sea, the Indian Ocean, and more especially in the Pacific. They are distinguished by Mr. Darwin into three sorts. First, *Barrier reefs*, or those which run parallel to the lines of coast of continents or islands, but at some distance from the shore—there being always an intervening space of deep sea. Second, *Fringing reefs*, or those which border the shores of continents or islands, without any intervening interval of sea, except a narrow channel only a few feet in depth. Third, *Atolls*, which are large rings of coral rock, having each a lagune or salt-water lake in its centre.

The coral islands of the Pacific consist for the most part of such atolls. Nothing can be more singular or beautiful than the aspect they present. The ring of coral reef generally rises only a few feet above the high-water mark, and is seldom more than half a mile broad—the average breadth being only three or four hundred yards. The form of the ring is generally either circular or oval; but in every case it is interrupted by a deep narrow channel, always situated on the leeward side of the island—that least exposed to the prevailing winds. This channel forms a direct communication between the outer ocean and the inner lagune, the depth of which is very various—sometimes as much as twenty or even thirty-eight fathoms.

The windward side of the island is always the highest, and the slope towards the leeward is gradual. In some cases the ring is

interrupted by a few narrow and shallow channels besides the great one; but it is more frequently continuous, save at the latter. The soil upon it is of great richness and fertility, supporting a most luxuriant vegetation, chiefly of cocoa-nut palms. It is this rich vegetation that adds beauty to the singularity of their appearance, and renders them such agreeable places of abode that many of them are inhabited. The number of those islands is enormous, and they are the chief constituents of the great archipelago, or rather group of archipelagoes, in the Pacific named Polynesia. There are also several groups of them in the Indian Ocean.

The mode in which these islands may have been formed has long been a subject of curious speculation among philosophers. The opinion which for a long time prevailed was, that these reefs had been reared by their tiny architects on the rims of the craters of submarine volcanoes; and this view possessed a good deal of plausibility. Not only are volcanoes numerous in the Pacific, but the general outline of the ring bears a remarkable resemblance to the margin of steep rugged rocks which usually surrounds a volcanic crater. Even the great channel, which all these islands possess, was easily explicable on this supposition; for almost all the margins of volcanic craters are broken on one side, the breach being caused by the overflow of lava.

Granting the existence of a submarine crater at the requisite depth, the explanation became easy. The corals erected their polypidoms on the margin of the crater, building it up until the top reached the surface at low water. Beyond this point they could not ascend, because the polyps die immediately on their exposure to the air. At this stage the top of the reef becomes thickly covered by the shells of mollusca, and by the action of the sea the coral formation is triturated into fine powder, which, with the aid of the water, forms a cement that agglutinates the shells into a mass. The upper portion of this mass, and of the reef itself, becomes gradually rent by the action of the sun and the weather, so that there are formed large loose fragments, which the waves toss up on the crown of the reef. There is thus by

degrees accumulated a ridge, which remains dry at the highest tide; and a sloping beach of shingle, with calcareous sand of dazzling whiteness, is gradually formed on its outer side. On the inner side of the ridge, the agglomeration of shells, broken corals, and calcareous sand, goes on accumulating over the crown of the reef, until the whole of it is raised above the level of the inner lagune. The surface of this dry portion erelong becomes a friable soil, in which stray cocoa-nuts washed ashore by the tides readily take root. The seeds of other plants are brought by birds, and there are often cast upon those low beaches logs of timber in which are the eggs of insects and lizards. Thus by degrees the flat surface of the coral-ring becomes covered with vegetation, and offers to the Polynesian who may happen to be drifted towards it in his canoe a temptation to make it his home.

Notwithstanding the plausibility of the theory that these reefs have been based on the rims of volcanic craters, several great difficulties stood in the way of its acceptance. The first arose out of the enormous dimensions of some of these rings—far exceeding those of the craters of any known volcanoes. Secondly, their great number, and the close proximity of many of them, were against the probability of their being the summits of craters. Thirdly, there was the uniformity in the position of the channel leading into the lagune. Fourthly, a yet stronger objection lay in the fact, ascertained by Mr. Darwin and others, that the coral polyp cannot live and build its polypidom when the depth of water exceeds 120 feet.

These facts suggested to the mind of Mr. Darwin another explanation, now much more generally adopted. While studying the structure of the fringing reefs—those which surround an island with only a very narrow piece of shallow water between the reef and the shore—it occurred to him that, were such an island gradually to subside, it would eventually become an atoll. For the reef would continue to ascend while the central portion of the island was subsiding, until the latter might become entirely covered with water, and so form the internal lagune. This view was strengthened by his finding some islands in a transition

state—that is, with a small islet in the centre of the lagune—the subsidence having not yet been sufficient to submerge the whole of the interior portion of the island.

This hypothesis obviates much of the difficulty connected with the other. It accounts for the vast depth to which the outer portion of the reef extends—far beyond the limits at which the coral can grow. It explains why the entrance to the lagune is always on the leeward side, the formation of this channel being primarily owing to the greater elevation of the reef to windward, and the scour of the tide between the lagune and the sea passing through at the lowest point, where its action would prevent the growth of the coral. The minor interruptions to the continuity of the ring Mr. Darwin explains by supposing them to have had their origin in the mouths of fresh-water streams, flowing from the interior of the island before its submergence. The uniformity of the height of the reefs above the sea-level, the enormous extent of some of them, and the manner in which they are clustered together, all become equally explicable on this hypothesis.

With respect to the lagune itself, it is always in the course of being gradually filled up, partly by the growth of corals finer and more delicate than those which build the outer reef, and partly by the shells of molluscs and crustaceans, mixed with the broken and powdered coral, which, by becoming a marly paste, tends to agglomerate them into a solid mass. In this manner the top of the atoll ultimately becomes a dry flat, wholly covered with vegetation.

To explain all the phenomena, however, presented by the islands of the Pacific, it is needful to suppose not a few of them, after having been formed into atolls, to have again been upraised by volcanic forces operating from beneath. There are some islands which have evidently been at one time atolls, whose lagunes have been gradually filled up in the manner above described, so as to present a uniform flat surface covered with vegetation; but their edges stand high out of the water, forming precipitous cliffs of coral rock—thus giving evidence that the entire island has been gradually upheaved. In other cases, however, where the island

presents a similar precipitous wall of coral rock for its coast, the interior is occupied by mountains obviously of volcanic origin—occasionally by volcanoes in a state of activity. In these latter cases the upheaving forces have been more energetic.

It thus appears that, while one set of islands is sinking, another is rising by the operation of the volcanic forces—the one phenomenon being probably the cause of the other. For the subsidence of the sinking islands must increase the pressure on the surface of the reservoirs of liquid lava underneath them, and cause them to seek relief in some other direction. The lava may either insinuate itself horizontally between the strata under some of the islands, so upheaving them gently; or, having made vertical fissures in the strata, it may be forced right up, and escape by forming a volcanic vent.

It will thus be perceived how intimate is the relation between the play of volcanic forces and the formation of coral islands, and how marvellous are the changes wrought by the operations of this tiny polyp.—*Abridged from* PONTON'S *Earthquakes and Volcanoes.*

PRACTICAL BEARINGS OF GEOLOGY.

DERIVING all our mineral and metallic treasures—our coal and iron, our gems and precious metals—from the crust of the Earth, it is of vast importance to be able to discriminate between mineral substances, to determine in what formations they occur, and to say where they are or are not to be found. The miner cannot proceed a step in safety without the guidance of mineralogy and geology; and though mining existed long before the truths of science assumed a technical aspect, yet do its operations proceed with certainty and precision only in proportion to the advancement of scientific generalization. Certain of our minerals—as coal and iron, for instance—occur in several of the stratified formations. To what formation does any special field belong? What its extent and thickness? Are its beds of easy access, or are they disturbed by dykes and dislocations? Again: certain other

minerals, as copper and tin, occur in lodes and veins; and as lodes and veins hold certain determinate directions in reference to the hills or eruptive axes of a district, what are the directions of these veins and cross-veins? Are they more prolific in one set of rocks than in another? Are the new cross-veins richer than the primary lodes? And what the character of the ore-stone which indicates this richness? Still further: some metals, as gold and tin, frequently occur in drifts of sand and gravel: whence have these gravels been derived? Can the veins be discovered from which they were originally worn out? Can the geologist in this way determine the gravels that are productive from those that are altogether barren? These and scores of similar questions occur in every mining adventure; and though they may sometimes be satisfactorily answered by the old-fashioned system of trial and error, yet every intelligent man knows that the strata and structure of a district can only be determined with certainty by the competent geologist. Under the old system of trial and error, and the superstition of the divining-rod, thousands have been expended in searches for minerals, where a glance from the merest tyro in geology could have told that no such minerals existed. Even as concerns the working miner, some scantling of geological information were desirable. A miner may be an excellent workman and yet know nothing of geology; but he may still be as good a workman and be acquainted with the general principles of the science, while some knowledge of the wonderful history of the rocks and minerals and fossils among which he is toiling might gratify his thoughts and tend to lighten his labours.

To the civil engineer—the constructer of roads, railways, and canals, the excavator of tunnels, the sinker of wells, and the drainer of cities—the importance of geological knowledge is so obvious that the fact requires little explanation. Possessed of a carefully-constructed lithological map, on which are delineated the various kinds of strata, their dip, strike, and other particulars, the engineer who can read these facts aright has the surest guide to the correct execution of his undertaking. He sees at once the

nature of the rocks through which his work has to pass, whether road, railway, or canal—can make deviations according to his knowledge—can estimate with certainty the expense of construction, and avail himself of minerals which he knows must lie in the vicinity, while one ignorant of geological truths would blindly pass by such advantages. In fact, not a railway or a canal can be constructed, not a tunnel excavated or a well sunk, without deriving important benefits from a knowledge of the geological structure of the district; and it is just from a want of this information that so many blunders are perpetrated, and important works rendered unremunerative to the proprietors.

The builder and the architect may also derive important assistance from the geologist, as regards both the position and abundance of certain rocks, the facilities with which they can be obtained, and their relative durability. The understanding of a geological map and geological section is quite as essential to the quarryman and the builder as it is to the civil engineer; and though experience is, after all, the best test of durability, yet, by observing the effects of natural weathering, the peculiarities of structure and composition, and similar characters, the geologist is often in a position to pronounce with certainty on the architectural fitness of any particular stratum. In Britain we have many varieties of building-stone, each of which has its peculiar quality of weight, hardness, strength, colour, facility of being dressed, cheapness, and so forth; and while these are admittedly matters for the builder and the engineer to test and decide, yet there are many points on which the advice of the geologist, and the geologist alone, may be taken with obvious advantage.

As with the builder, so with the farmer and the land-valuator. The value of a soil depends at once upon its composition and the nature of the subsoil and rocks underlying. A soil may possess all the mineral ingredients necessary to fertility, and yet the underlying rocks may afford no facilities for natural drainage, and thus render the soil wet, cold, and unproductive. A geological map of a district, exhibiting the position and extent of its trap-rocks, lime-stones, clays, and gravels, is of prime importance

to the agriculturist, not only as indicating the nature of the superincumbent soils, but as pointing out the facilities with which lime, marl, clay, and other admixtures may be obtained for the permanent improvement of that which may be naturally deficient. In fact, without a knowledge of the mineral structure of an estate, it is impossible to ascertain its true value; and he who can read aright the delineations of the geologist, even though not a professed geologist himself, is always the safest man to be consulted, whether by the proprietor, the purchaser, or lessee. It may be true that the functions of the land-valuator are altogether distinct from those of the mineral-surveyor, and that the report of the one should be accompanied by the report of the other; but even in the valuing of land for mere agricultural purposes, the man who is ignorant of the mineral facilities of a district—its natural drainage, available rocks, limestones, clays, marls, shell-sands, phosphates, and so forth—can give but a very uncertain and unsatisfactory opinion.

Again: to the painter who has to delineate the aspects of the landscape, and to the landscape-gardener, who has to fence, plant, and lay out estates, a knowledge of the leading principles of geology is also of special importance. As the painter of the human figure is benefited in his art by a knowledge of anatomy, so the painter of the landscape must derive advantages from an understanding of the nature of the rocks which give character to, and form, as it were, the skeleton of his scenery. Every formation has its own peculiar scenery—bold, rugged, rounded, or level, as the case may be; and surely he who is acquainted with the causes of these peculiarities is more likely to excel in his art, than one who is altogether unacquainted with the subject. So is it with the gardener who would add new features to, or bring out more prominently the existing beauties of the landscape. Acquainted with surface peculiarities and the causes that have produced them, he may occasionally succeed; but, ignorant of these, he only mars where he seeks to mend, and renders his efforts incongruous and ridiculous. "The laws of the organization of the Earth," says Mr. Ruskin, "are distinct and fixed as those of the

animal frame—simpler and broader, but equally authoritative and inviolable. Their results may be arrived at without knowledge of the interior mechanism; but for that very reason ignorance of them is the more disgraceful, and violation of them more unpardonable. They are in landscape the foundation of all other truths—the most necessary, therefore, even if they were not in themselves attractive. But they are as beautiful as they are essential; and every abandonment of them by the artist must end in deformity, as it begins in falsehood."

Nor is it only the miner, the engineer, builder, farmer, landscape-gardener, painter, and the like, who can turn to profitable account the deductions of geology. The capitalist who speculates in land and mines, the emigrant, the traveller and voyager, the statistician and statesman, may all derive assistance from the same source, and bring a knowledge of its facts to bear on the progress of their respective countries. So also the holiday tourist, the military officer stationed in a distant country, and others similarly situated, if possessed of the requisite knowledge, might do good service, not only to the cause of science, but to the furtherance of our material prosperity. Indeed we do not affirm too much when we assert, that had one tithe of those who, during the last fifty years, have travelled or settled in America, Australia, New Zealand, India, and other countries, been possessed even of a smattering of geology, these countries, as to their substantial wealth and social progress, would have been in a very different position at the present day.

To the general student of Nature also—the man who cultivates Science for her own sake, and not for the material advantages which such knowledge may confer—the study of geology offers many inducements and attractions. The assistance which it has conferred, and the new light its deductions have thrown on the other branches of natural science, must ever rank among its highest claims to general attention. The comparatively recent study of Physical Geography, in all that relates to the surface-configuration of the globe—its climate and temperature, the distribution of plants and animals, and even touching the

development of man himself, as influenced by geographical position—can only lay claim to the character of a science when treated in connection with the fundamental doctrines of geology. So also, in a great degree, of Botany and Zoology: the reconstructing, as it were, of so many extinct genera and species, has given a new significance to the science of Life; and henceforth no view of the vegetable or animal kingdom can lay claim to a truly scientific character that does not embody the discoveries of the Palæontologist. In fact, so inseparably woven into ONE GREAT SYSTEM OF LIFE are fossil forms with those now existing, that we cannot treat of the one without considering the other; and can never hope to arrive at a knowledge of Creative Law by any method which, however minute as regards the one, is not equally careful as concerns the other. Combining, therefore, its theoretical interest with its high practical value—the complexity and nicety of its problems, as an intellectual exercise, with the substantial wealth of its discoveries—the new light it throws on the duration of our planet and the wonderful variety of its past life, with the certainty it confers on our industrial researches and operations,—Geology becomes one of the most important of modern sciences, deserving the study of every cultivated mind, and the encouragement of every enlightened government.—PAGE: *Geology as a Branch of Education.*

BOTANICAL.

BOTANY: ITS AIM AND OBJECT.

THE science of Botany (from the Greek word *botané*, a plant) includes everything relating to the vegetable kingdom, whether in a living or in a fossil state. Its object is not, as some have supposed, merely to name and arrange the vegetable productions of the globe. It embraces a consideration of the external forms of plants; of their anatomical structure, however minute; of the functions which they perform; of their arrangement and classification; of their distribution over the globe at present and during former epochs; and of the uses to which they are subservient. It examines the plant in its earliest state of development, when it appears as a simple cell, and follows it through all its stages of progress until it attains maturity. It takes a comprehensive view of all the plants which cover the Earth, from the minutest lichen or moss, only visible by the aid of the microscope, to the most gigantic productions of the tropics. It marks the relation which subsists between all members of the vegetable world, and traces the mode in which the most despised weeds contribute to the growth of the mighty denizens of the forest. It is a science, then, which demands careful and minute investigations—requires much observation and research, and is well fitted to train the mental powers to vigorous and prompt action.

Botany may be divided into the following departments:—

1. *Structural* Botany, having reference to the anatomical structure of the various parts of plants, including Vegetable Histology, or the microscopic examination of tissues (Gr. *histos*, a tissue; and *logos*, reasoning).

2. *Morphological* Botany, or the study of the form of plants and their organs.

These two departments are often included under the general term of Organography, which includes a consideration of the minute structure of the various parts of plants, and of the forms which they assume. In prosecuting it, the student may either consider analytically the anatomy of each part of the plant at the same time that he examines its form; or he may, in the first place, consider those structures which enter generally into the composition of every part of the plant, and then study synthetically the mode in which they are grouped together in the different organs. The latter is the method which has been usually adopted, and seems, upon the whole, best fitted for the purposes of the student.

3. *Physiological* Botany, by some termed Organology, or the study of the life of the entire plant and its organs, or the consideration of the functions of the living plant. This department, known also as Vegetable Physiology, embraces a consideration of plants in a state of activity, and performing certain functions which are intimately connected with their life and duration. These vital functions may be traced through all stages of growth, from the first cell of the embryo up to the fully-developed plant. The study of the function of the simple *plant-cell* aids much in the elucidation of all the phenomena of plant-life. The cell of the yeast-plant, and of the red and green snow-plants, is capable of performing all the functions of nutrition and reproduction. It absorbs fluids through its walls, enlarges, elaborates secretions, and forms new cells, which propagate the individual. Thus a simple isolated cell grows or enlarges, is endowed with a certain plastic or formative vital power, by which new cells are produced, exhibits frequently movements in its interior, forms secretions, becomes often thickened by deposits on its walls, and ultimately dies. Here, then, in the cell, in all its stages of growth, formation of secretions, reproduction, and decay, is an epitome of vegetable life.

4. *Taxological* or Systematic Botany (Gr. *taxis*, arrangement) relates to the description, classification, and nomenclature

of plants. We see around us various kinds or sorts of plants which more or less resemble each other. In Systematic Botany we endeavour to mark these resemblances, and to determine their relations. It is impossible to give a scientific arrangement of the plants of the globe without a thorough knowledge of structure and morphology, and without an extensive knowledge of the vegetation of all parts of the world. We cannot expect to determine the system on which plants have been grouped until we have an accurate acquaintance with all the forms they present. Hence, in the present state of our knowledge, there must be imperfection in our attempts at systematizing. The floras of many regions in Africa, India, China, Australia, and America, are still unknown; and we may therefore conclude that in all systems there will be gaps, to be filled up as our knowledge increases. Sufficient, however, is known to enable us to group plants, according to certain alliances, into classes, orders, genera, and species, of which upwards of 120,000 are already known to botanists.

5. *Geographical* Botany, which restricts itself to the consideration of the mode in which plants are distributed over the different quarters of the globe. The nature of the vegetation covering the Earth varies according to climate and locality. Plants are fitted for different kinds of soil, as well as for different amounts of temperature, light, and moisture. From the poles to the equator there is a constant variation in the nature of the floras. Between the palms, bananas, and orchids of the tropics, and the lichens and mosses of the Arctic and Antarctic regions, there is a series of regulated changes in the number and forms of the members of the vegetable kingdom. The same thing is observable in the vegetation of lofty mountains at the equator, in ascending from the base to the summit. To study the vegetable kingdom, therefore, as arranged into zones of latitude and altitude, zones of latitude and depth, and into regions and provinces, according to the prevailing forms, is the object of Geographical Botany.

6. *Palæontological* Botany (Gr. *palaios*, ancient; *onta*, beings; *logos*, reasoning) relates to the study of the plants found in a

fossil state in the various stratified systems of which the Earth's crust is composed. The vegetation of the globe, during the different stages of its formation, has undergone very evident changes. At the same time there seems to be no reason to doubt that the plants may all be referred to the great classes distinguished at the present day. The relative proportion of these classes, however, has been different, and the predominance of certain forms has given a character to the vegetation of different epochs. The further we recede in geological history from the present day, the greater is the difference between the fossil plants and those which now occupy the surface. At the time when the coal-fields were formed, the plants covering the Earth belonged to genera and species not recognized at the present day. As we ascend higher, the similarity between the ancient and the modern floras increases, and in the latest stratified rocks we have in certain instances an apparent identity, at least as regards genera. At early epochs the flora appears to have been uniform, to have presented less diversity of forms than at present, and to have been similar in the different quarters of the globe. To describe these ancient floras, to compare them with that still existing, and to arrange the whole, as far as possible, into one great system of plant-life, is the object of Palæontological Botany.—*Adapted from* BALFOUR'S *Class-Book of Botany*.

VEGETABLE LIFE: ITS GOVERNING CONDITIONS.

THE great regulators of plant-life are heat, light, and moisture. Such is the order of nature now, and such, we are bound to believe, have been the ordainings of creation from the earliest moment that the vegetable cell was evoked into existence. Under the tropics, both individual exuberance and specific variety attain their maximum intensity; in the temperate zones this intensity gradually declines; while in the arctic regions vegetable life dwarfs and diminishes till it ultimately disappears and gives place to utter sterility. As we start from the equator, each great belt—equatorial, tropical, sub-tropical, warm-temperate, cold-

temperate, sub-arctic, arctic, and polar *—presents its own distinctive features; and though the zones of the southern hemisphere may differ in genera and species from those of the northern, there is still in the respective stages a sufficient resemblance of growth, colouring, and inflorescence, to prove that, latitude for latitude, the prime governing influence is essentially solar. As with latitude, which is influenced in the main by light and heat, so with height above the level of the ocean—an advance upwards into the rarer regions of the atmosphere being equivalent, in some measure, to an advance northwards or southwards into the colder latitudes of either pole. The mountain that has its base waving with the palms and tree-ferns of India, may have its sides clothed with the oaks and pines of Europe, its higher cliffs with the dwarf willows and mosses of Nova Zembla, while its snowy peaks are as void of life as the ice-bound shores of the Arctic Circle. Besides these conditions, there are others of site, or locality, or *habitat*—conditions which require that the weeds of the ocean should differ from the plants of the marsh, the plants of the marsh from the herbage of the open plain, and the verdure of the plain from that of the mountain forest. Nay, more: there are some tribes that will flourish only in rich organic mould, others that prefer the shingly surface of the arid desert; some that exist only on calcareous soils, and others unknown beyond the limits of the salt marsh. Wherever the prime conditions of heat, light, and moisture are present, there the vegetable germ manifests itself—here incrusting the naked rock, there mantling the surface of the stagnant pool—now rooting itself in the decay of its own kind, and at times finding a *habitat* even in the tissues of the animal structure. More than this: every climatic influence, however faint, leaves its impress on vegetable life. A thicker layer is added to the concentric growth of the timber-tree during a genial than during an ungenial summer; the southern slopes of

* The equatorial zone extends on both sides of the equator to about 15° of latitude; the tropical from 15° to the tropics; the sub-tropical from the tropics to 34°; the warmer temperate from 34° to 45°; the colder temperate from 45° to 58°; the sub-arctic from 58° to the polar circle; the arctic from the polar circle to latitude 72°; and the polar zone from 72° to the poles.

a hill are more verdant and flowery than those of its northern side; some plants luxuriate in the sea-breeze which would be death to others; and the leafiest side of a tree is ever that which is most accessible to the open sunshine. Again: plants that grow in localities marked by sudden extremes of heat and cold are always more variable in stature, habit, and foliage, than those which flourish under the steadier influences of a genial climate; and thus we can judge of the climate of a newly-discovered country as well as of the conditions that prevailed and affected plant-life during the deposition of a rock-formation which took place thousands of ages ago. Still further, and apparently altogether independent of climate: certain families are restricted to certain regions, beyond which, and under the present arrangements of sea and land, they naturally never pass; and thus it is that the Cape of Good Hope rejoices in its pelargoniums and geraniums; China in its teas and camellias; Australia in its eucalypti and casuarinæ; the Spanish peninsula in its evergreen oaks; and the pampas of South America in their gigantic thistles and clover, to the almost total exclusion of other species. Descending from family *regions* to the narrower *provinces* of genera and species, we find some limited to a single valley, to a solitary island, or, it may be, to some particular mountain-slope, which, as far as science can perceive, enjoys no external influence that is not equally shared by the other slopes that surround it.—PAGE's *Past and Present Life of the Globe.*

THE SLEEP OF PLANTS.

THE habit which many plants have of folding up their leaves and flowers during the night was designated by Linnæus *the sleep of plants.* This term, borrowed from the animal kingdom, does not, however, represent the same idea in both. In animals, sleep indicates a repose of the nervous system, a flaccid drooping of the members, a limpness in the articulations; in vegetables it indicates a changed state, but in this state there is the same rigidity

and the same constancy as in the diurnal position. We may break the sleeping leaf rather than maintain it in the position which belongs to it during the day.

It was in the bird's-foot trefoil that Linnæus remarked for the first time the difference between the attitude of the leaves during the day and during the night. Scarcely had he made this remark when he came to the conclusion that this phenomenon would be found not to be confined to this single plant, but would be general in vegetable life. From that time, every night Linnæus tore himself from sleep, and in the silence of nature studied the plants in his garden. At each step he discovered a new fact. Each fact, when put in evidence by a first observation, was rapidly confirmed by crowds of facts quite analogous to the first; and Linnæus very soon satisfied himself that the change in the position of leaves during the night was observable in a considerable number of vegetables, and that in the absence of light plants quite changed their physiognomy, so that it became very difficult to recognize them from their bearing. He further states that it was the absence of light, and not nocturnal cold, which was the principal cause of the phenomenon, for plants in hot-houses closed themselves during the night just like those which were exposed in the open air. He recognized, also, that this difference is much less apparent in young plants than in more matured ones.

The illustrious Swedish botanist made many observations on the diversity of position that leaves affect during the night, and he even attempted a classification of those differences. The most general idea which he sought to establish was, that the positions differed according as the leaves were simple or compound. Linnæus thought that the object, in these circumstances, was to place the young shoots under shelter from nocturnal cold and from the effects of the air. It is among the composite leaves, in short, that the difference between the waking and sleeping is most clearly indicated.

The leaflets of the trefoil stand erect, curving in a longitudinal direction in such a manner as to form a sort of cavity or

cradle. In the wood-sorrel the leaflets usually rest in such a manner as to turn their lower surfaces inwards and show only their upper surfaces. In the bladder senna the leaflets rise vertically in such a manner as to turn their upper surfaces towards each other. The cassias have, on the contrary, the leaflets depressed and folding back on the lower surfaces. The leaves of the orach root fall back upon the young shoots and enclose them, as if to protect them from the atmosphere. The chickweed closes its leaves during the night, and only opens them in the morning. The evening primrose has similar properties, and, like the trefoil, forms during the night a sort of cradle for the reception of the leaves. On the other hand, many of the mallows roll their leaves into the form of a coronet. The vetch, the sweet-pea, the broad bean, rest their leaves during the night one against the other, and seem to sleep.

What is the cause of the phenomenon which we designate the *sleep of plants?* It occurs in all hygrometrical conditions (Gr. *hygros*, moisture) of the atmosphere, and the hours during which it affects them is not influenced by any change of temperature. De Candolle, a celebrated French botanist, supposed that the absence of light was the direct cause of the phenomenon. To assure himself of this, he subjected plants, whose leaves are disposed to sleep, to the action of artificial light, furnished by two lamps, which were, when united, equal to five-sixths of daylight. The results were varied. "When I exposed," he says, "the sensitive plant to the light during the night, and to the shade during the day, I observed that at first the plants opened and closed their leaves without any fixed rule, but after a few days they seemed to submit to their new position, and opened their leaves in the night, which was day to them, and closed them in the morning, which was their night. When exposed to a continuous light, they had, as in their ordinary state, alternations of sleeping and waking, but each of the periods was shorter than ordinary. On the other hand, when exposed to continuous obscurity, they still presented the alternations of sleeping and waking, but very irregularly."

De Candolle adds that he was unable to modify the sleep of two species of sorrel either by light or darkness, or by light at other than the natural periods. It may be concluded, then, from these facts, that the movements of sleeping and waking are connected with some disposition inherent in the vegetable, that is thrown into special activity by the stimulating action of light, which acts with different intensity on different vegetables, so that the same amount of light produces different results in different species.—*Abridged from* FIGUIER'S *Vegetable World.*

TROPICAL FORESTS OF SOUTH AMERICA.

THE aspects of these marvellous forest-growths vary according to the nature of the soil and the abundance of water by which they are traversed. If they are not the seat of a constant supply of moisture, or if the moisture is only renewed by periodical rains, the drought stops the vegetation, and it becomes intermittent, as in European climates. On the other hand, when excited by the ceaseless action of humidity and heat, these virgin forests remain in a state of continual activity and verdure. The winter is only distinguished from the summer by a shade of colour in the foliage; and if some of the trees lose their leaves, it is to assume immediately a new appearance. "When an European," says M. Auguste de St. Hilaire, "arrives in South America, and sees from a distance the untrodden forests for the first time, he is no longer astonished at all the singular forms which he admired in European hot-houses: here they are mingled in masses and lost. But he is astonished to find in the outline of the forests so little difference between those of his own country and those of the New World. If anything strikes him, it is only the grandeur of the proportions and the deep green colour of the leaves; which, under the most brilliant sky imaginable, impart a grave and severe aspect to the landscape."

In order to appreciate all the beauties of a tropical forest, we must plunge into retreats as old as the world itself. Nothing

there reminds us of the fatiguing monotony of our Oak and Fir forests: each tree has a bearing peculiar to itself. Each has its own foliage, and often its own peculiar shade of verdure. Gigantic specimens of vegetation, each belonging to different, sometimes to remote families, mingle their branches, and blend their foliage. Five-leaved Bignoniæ grow beside Cesalpinas, and the golden leaves of the Cassia spread themselves in falling on the green feathery fronds of the Tree-Fern. Myrtles and Eugenias, with their thousand-times divided branches, are finely contrasted with the elegant simplicity of the Palms; and Cecropias spread their broad leaves and branches, which resemble immense candelabra, among the delicate leaflets of the Mimosæ. There are trees with perfectly smooth bark, others defended by prickly spines; and the enormous trunk of a species of Wild-Fig spreads itself out like oblique blades, which seem to support it like so many arched buttresses.

The obscure flowers of our Beeches and Oaks are only perceptible to naturalists; but in the forests of South America gigantic trees often display the most brilliant colours in their corollas. Long golden clusters hang from the branches of the Cassia, and the Vochysias erect their spikes of odd-shaped yellow blossoms. Yellow and purple corollas, longer than those of our Fox-glove cover in profusion the tree of the trumpet-flowered Bignonia; and the Chorisias are decked in flowers which somewhat resemble our Lilies, but of brighter and more varied hues. Certain vegetable forms, which assume at home very humble proportions, present themselves with a floral pomp unknown in temperate climates. Some Boraginaceæ become shrubs, and many Euphorbias assume the proportions of trees, offering an agreeable shelter under their thick umbrageous foliage.

But it is principally among the Grasses that the greatest difference is observable. Of these there are a great number which attain no larger dimensions than our Wild Oat, forming masses of grass only distinguished from European species by their more branching stems and larger leaves; but others shoot up into lofty tree-like stalks of graceful appearance. Chief among such are

the bamboos, rearing their stems sixty or eighty feet in height, and throwing out at regular intervals their whirled leaves, which form elegant arbours between the more massive trees.

It is to the *Lianes*, or climbers, however, that the tropical forests are chiefly indebted for their picturesque beauty and wild tangling luxuriance. The Honey-suckle and Ivy give but a faint idea of the appearance presented by the crowd of climbing and creeping plants, belonging to many different families. These are the Bignonias, Bauhinias, Hippocrateas, &c.; and while they all require a support, each has a bearing peculiar to itself. One of these climbing parasites will encircle the trunk of the largest tree to a prodigious height; the marks left by the old leaves seeming in their lozenge-shaped design to resemble the skin of a serpent. From this parasitic stem spring large leaves of a glossy green, while its lower parts give birth to slender air-roots, which descend again to the earth, straight as a plumb-line. The tree which bears the Spanish name of *Cipo-Matador*, the murderous liane, has a trunk as straight as our poplar, but so slight that it cannot support itself alone, but must find support on a neighbouring tree more robust than itself. It presses against its stem, aided by its aërial roots, which embrace it at intervals, like so many flexible osiers, by which it secures itself and defies the fiercest hurricanes. Some lianes resemble waving ribbons; others are twisted in large spirals. Hanging in festoons, spreading between the trees, and darting from one to another, twining round them and forming into masses of stem, leaves, and flowers, they get so commingled that it is often difficult to distinguish between them.

Thousands of different species of shrubs, springing up around the roots of large trees, fill up the intervals between them; while Tillandsias and Orchids, with flowers of strange and whimsical shape, nestle in their clefts, and depend from their branches. Numerous streams and creeks run through these forests, imparting at once a freshness and a gloom; while along their banks springs up a dense undergrowth of mosses, club-mosses, and ferns.—*Compiled from* FIGUIER'S *Vegetable World*.

TROPICAL AND TEMPERATE VEGETATION CONTRASTED.

There is grandeur and solemnity in the tropical forest, but little of beauty or brilliancy of colour. The huge buttress trees, the fissured trunks, the extraordinary air roots, the twisted and wrinkled climbers, and the elegant palms, are what strike the attention and fill the mind with admiration and surprise and awe. But all is gloomy and solemn, and one feels a relief on again seeing the blue sky, and feeling the scorching rays of the sun.

It is on the roadside and on the rivers' banks that we see all the beauty of the tropical vegetation. There we find a mass of bushes and shrubs and trees of every height, rising over one another, all exposed to the bright light and fresh air; and putting forth, within reach, their flowers and fruit, which, in the forest, only grow far up on the topmost branches. Bright flowers and green foliage combine their charms, and climbers with their flowery festoons cover over the bare and decaying stems. Yet, pick out the loveliest spots, where the most gorgeous flowers of the tropics expand their glowing petals, and for every scene of this kind we may find another at home of equal beauty, and with an equal amount of brilliant colour.

Look at a field of buttercups and daisies; a hillside covered with gorse and broom; a mountain rich with purple heather; or a forest glade azure with a carpet of wild hyacinths—and they will bear a comparison with any scene the tropics can produce. I have never seen anything more glorious than an old crab-tree in full blossom; and the horse-chestnut, lilac, and laburnum will vie with the choicest tropical trees and shrubs. In the tropical waters are no more beautiful plants than our white and yellow water-lilies, our irises, and flowering rush: for I cannot consider the flower of the *Victoria regia* more beautiful than that of the *Nymphæa alba*, though it may be larger; nor is it so abundant an ornament of the tropical waters as the latter is of ours.

But the question is not to be decided by a comparison of indi-

vidual plants, or the effects they may produce in the landscape, but on the frequency with which they occur, and the proportion the brilliantly coloured bear to the inconspicuous plants. My friend Mr. R. Spruce, now investigating the botany of the Amazon and Rio Negro, assures me that by far the greater proportion of plants gathered by him have inconspicuous green or white flowers; and with regard to the frequency of their occurrence, it was not an uncommon thing for me to pass days travelling up the rivers without seeing any striking flowering tree or shrub. This is partly owing to the flowers of most tropical trees being so deciduous: they no sooner open than they begin to fall; the Melastomas, in particular, generally burst into flower in the morning, and the next day are withered, and for twelve months that tree bears no more flowers. This will serve to explain why the tropical flowering trees and shrubs do not make so much show as might be expected.

From the accounts of eye-witnesses, I believe that the forests of the southern United States present a more gay and brilliant appearance than those of tropical America. Humboldt, in his "Aspects of Nature," repeatedly remarks on the contrasts between the steppes of Tartary and the llanos of the Orinoco. The former, in the temperate zone, are gay with the most brilliant flowers; while the latter, in the tropics, produce little but grasses and sedges, and but few and inconspicuous flowering plants. Mr. Darwin mentions the brilliancy of the flowers adorning the plains of Monte Video, which, with the luxuriant thistles of the pampas, seems hardly equalled in the campos of tropical Brazil, where, with some exceptions, the earth is brown and sterile. The countless beautiful geraniums and heaths of the Cape cease on entering the tropics, and we have no account of any plants equally striking and brilliant supplying their place.

What we may fairly allow of tropical vegetation is, that there is a much greater number of species, and a greater variety of forms, than in the temperate zones. Among this great variety occur, as we might reasonably expect, the most striking and brilliant flowers, and the most remarkable forms of stem and

foliage. But there is no evidence to show that the proportion of species bearing brightly-coloured, compared to those bearing inconspicuous flowers, is any greater in the tropics than in the temperate regions; and with regard to individuals—which is, after all, what produces the effects of vegetation—it seems probable that there is a greater mass of brilliant colouring and picturesque beauty produced by plants in the temperate than in the tropical regions.

There are several reasons which lead us to this conclusion. In the tropics a greater proportion of the surface is covered either with dense forests or with barren deserts, neither of which can exhibit many flowers. Social plants are less common in the tropics, and thus masses of colour are less frequently produced. Individual objects may be more brilliant and striking, but the general effect will not be so great as that of a smaller number of less conspicuous plants, grouped together in masses of various colours, so strikingly displayed in the meadows and groves of the temperate regions.

The changing hues of autumn and the tender green of spring are particular beauties which are not seen in tropical regions, and which are quite unsurpassed by anything that exists there. The wide expanse of green meadows and rich pastures is also wanting; and however much individual objects may please and astonish, the effect of the distant landscape is decidedly superior in the temperate parts of the world. In the tropics, singular forms of stems and climbers, gigantic leaves, elegant palms, and individual plants with brilliant flowers, are the characteristic features. In temperate regions an endless carpet of verdure, with masses of gay blossoms, the varying hues of the foliage, and the constant variety of plain and forest, meadow and woodland, more than individual objects, are what fill the beholder with delight.—*Abridged from* WALLACE'S *Travels in the Amazon and Rio Negro.*

TEA PLANTATIONS IN CHINA.

In the black-tea districts, as in the green, large quantities of young plants are yearly raised from seeds. These seeds are gathered in the month of October, and kept mixed up with sand and earth during the winter months. In this manner they are kept fresh till spring, when they are sown thickly in some corner of the farm, from which they are afterwards transplanted. Occasionally the seeds are sown in the rows where they are destined to grow, and of course are in that case not transplanted, but merely thinned out to the proper intervals. When about a year old they are from nine inches to a foot high, and ready for transplanting. They are placed in rows about four feet apart. Five or six plants are put together in each hole, and these little patches are usually about three or four feet from each other in the rows. Sometimes, however, when the soil is poor, they are planted very close in the rows, and have a hedge-like appearance when they are full-grown.

The young plantations are always made in spring, and are well watered by the rains which fall at the change of the monsoons in April and May. The moist weather at this season enables the young plants to establish themselves in their new quarters, where they require little labour afterwards, except in keeping the ground free from weeds. A plantation of tea, when seen at a distance, looks like a little shrubbery of evergreens. As the traveller threads his way amongst the rocky scenery of Woo-e-shan, he is continually coming upon these plantations, which are dotted upon the sides of all the hills. The leaves are of a rich dark green, and afford a pleasing contrast to the strange and often barren scenery which is everywhere around.

The natives are perfectly aware that the practice of plucking the leaves is very prejudicial to the health of the tea shrubs, and always take care to have the plants in a strong and vigorous condition before they commence gathering. The young plantations are generally allowed to grow unmolested for two or three years,

or until they are well established, and are producing strong and vigorous shoots; and it would be considered very bad management to begin to pluck the leaves until this is the case. Even when the plantations were in full bearing, I observed that the natives never took away too many leaves from the weaker plants, and sometimes passed them altogether, in order that their growth might not be checked.

But under the best mode of treatment, and with the most congenial soil, the plants ultimately become stunted and unhealthy, and are never profitable when they are old. Hence, in the best managed tea districts, the growers yearly remove old plantations and supply their place with fresh ones. The length of time which a tea plantation will remain in full bearing depends, of course, on a variety of circumstances; but with the most careful treatment, consistent with profit, the plants will not do much good after they are ten or twelve years old, and in many instances they are dug up and the space re-planted before that time.—FORTUNE'S *Visit to the Tea Districts of China and India.*

THE COCOA-NUT TREE.

THE Cocoa-nut Palm (*Cocos nucifera*) is found over all the tropical regions of both continents, and is one of the most valuable trees in the world. Its real origin is doubtful, some considering its native country to be Asia, others America. The cocoa-nut tree rises like a slender column, from 60 to 100 feet in height, and is crowned by twelve or fifteen pinnated leaves about 13 feet long, drooping like gigantic ostrich feathers, and giving the aspect of a tuft of vegetable plumes. It is chiefly confined in its growth to the borders of the sea, where the soil is impregnated with salt; and its fruit is capable of being carried to any distance by the waves and currents, and, when thrown upon shore, of taking root and flourishing. The fruit is a nut with a very hard shell, enclosed in an outer fibrous husk about the size of a man's head; and the kernel, which is hollow, white, and fleshy, contains nearly

a cupful of a clear liquid, which forms an agreeable and refreshing beverage. A full-grown tree generally yields from eighty to one hundred nuts annually; and these, together with the trunk and leaves, are of incalculable value—being put to a thousand uses for the inhabitants of tropical regions. The following passage from Bonifas-Guizot's "Botany for Youth," whether taken allegorically or as the actual experiences of a traveller, gives with some piquancy an idea of the infinitely varied advantages which are derived by the natives from the cocoa-nut palm and its products:—

"Imagine a traveller passing through one of those countries situated under a burning sky, where coolness and shade are so rare, and where habitations, in which to take repose so necessary to the traveller, are only to be found at considerable distances. Panting and dispirited, the poor traveller at length perceives a hut surrounded by some trees with straight erect stems, surmounted by immense tufts of great leaves, some being upright and others pendent, giving an elegant and agreeable aspect to the scene. Nothing else near the cabin indicates cultivated land. At this sight the spirits of the traveller revive; he collects his strength, and is soon beneath the hospitable roof. His host offers him a sourish drink, with which he slakes his thirst: it refreshes him. When he has taken some repose, the Indian invites him to share his repast. He serves up various meats contained in a brown-looking vessel, smooth and glossy; he serves also some wine of an extremely agreeable flavour. Towards the end of the repast his host offers him succulent comforts, and he is made to taste some excellent spirits. The astonished traveller asks who in this desert country furnishes him with all these things?

"'My cocoa-nut tree,' is the reply. 'The water I presented you with on your arrival is drawn from the fruit before it is ripe, and some of the nuts which contain it weigh three or four pounds. This almond, so delicate in its flavour, is the kernel when ripe; this milk, which you find so agreeable, is drawn from the nut; this cabbage, whose flower is so delicate, is the top of the cocoa-tree—but we rarely regale ourselves with this delicacy, for the

tree from which the cabbage is cut dies soon after. This wine, with which you are so satisfied, is still furnished by the cocoa-nut tree. In order to obtain it, an incision is made into the *spathe* or sheath that encloses the opening flowers. It flows from it in a white liquor, which is gathered in proper vessels, and we call it "palm-wine;" exposed to the sun, it gets sour and turns to vinegar. By distillation we obtain this very good brandy which you have tasted. The sap has supplied the sugar with which these preserves are sweetened. These vessels and utensils, these cups, goblets, and lamps, have been made out of the shell of the nut.

"'Nor is this all. This habitation itself I owe entirely to these invaluable trees. With their wood my cabin is constructed; their leaves, dried and plaited, form the roof; made into an umbrella, they shelter me from the sun in my walks; the clothes which cover me are woven out of the filaments of their leaves; these mats, which serve so many useful purposes, proceed from them also; the sifter which you behold was found made to my hand in that part of the tree whence the leaves issue; with the same leaves woven together we can make sails for our boats, and these boats themselves are built of cocoa-nut timber. The tough fibre (*coir*) which envelops the nut is much preferable to tow for calking ships—it does not rot in the water, and it swells in imbibing it; it can likewise be twisted into excellent cable and cordage, or woven into light and most durable matting. Finally, the delicate oil that has seasoned many of our meats, and that which burns in my lamp, are expressed from the fresh kernel.'

"The stranger would listen with astonishment to the poor Indian, who, having only his cocoa-nut tree, had nearly everything which was necessary for his existence. When the traveller was disposed to take his departure, his host again addressed him: 'I am about to write to a friend in the city; may I ask you to charge yourself with my communication?' 'Yes; but will your cocoa-nut tree still supply you with what you want?' 'Certainly,' said the Indian: 'with the sawdust from severing the leaves I made this ink, and with the leaves this parchment;

in former times it was used to record all public and memorable acts.' "

THE PALMYRA PALM.

The Palmyra (*Borassus flabelliformis*) is another invaluable palm, and one of the most beautiful of the family. With the exception of the date, the palmyra has probably the widest geographical distribution. It extends from the confines of Arabia to the isles of Amboyna and Timor, and is found in every region of Hindoostan, from the Indus to Siam. It is cultivated more or less in every district of Ceylon (says Sir E. Tennent), but grows in such profusion over the north, and especially in the peninsula of Jaffna, as to form extensive forests, whence its timber is exported for rafters to all parts of the island, as well as to the opposite coast of India, where, though the palmyra grows luxuriantly, its wood, from local causes, is too soft and perishable to be used for any purpose requiring strength and durability—qualities which, in the palmyra of Ceylon, are pre-eminent. To the inhabitants of the northern provinces this invaluable tree is of the same importance as the cocoa-nut palm is to the natives of the south. Its fruit yields them food and oil; its juice, "palm wine" and sugar; and its leaves, besides serving as roofs to their dwellings and fences to their farms, supply them with matting and baskets, with head-dresses and fans, and serve as a substitute for paper for their deeds and writings, and for the sacred books which contain the traditions of their faith. It has been said with truth, that a native of Jaffna, if he be contented with ordinary doors and mud walls, may build an entire house, with walls, roof, and covering from the palmyra palm. From this same tree he may draw his wine, make his oil, kindle his fire, carry his water, store his food, cook his repast, and sweeten it if he pleases; in fact, live from day to day dependent on his palmyra alone. Multitudes so live, and it may be safely asserted that this tree alone furnishes one-fourth the means of subsistence for the population of the northern provinces.

PLANT-DWARFING IN CHINA AND JAPAN.

In Japan, as in China, dwarf plants are greatly esteemed; and the art of dwarfing has been brought to a high state of perfection. President Meylau, in the year 1826, saw a box, which he describes as only one inch square by three inches high, in which were actually growing and thriving, a bamboo, a fir, and a plum-tree, the latter being in full blossom. The price of the portable grove was 1200 Dutch gulden, or about £100 sterling. In the gardens of Su-mae-yah (Japan) dwarf plants were fairly represented, although I did not meet with anything so very small and so very expensive as that above mentioned. Pines, junipers, thujas, bamboos, cherry and plum trees, are generally the plants chosen for the purpose of dwarfing.

The art of dwarfing trees, as commonly practised in China and Japan, is in reality very simple and easily understood. It is based upon one of the commonest principles of vegetable physiology. Anything which has a tendency to check or retard the flow of the sap in trees also prevents, to a certain extent, the formation of wood and leaves. This may be done by grafting, by confining the roots in a small space, by withholding water, by bending the branches, and by a hundred other ways, which all proceed upon the same principle. This principle is perfectly understood by the Japanese, and they take advantage of it to make nature subservient to this whim of theirs. They are said to select the smallest seeds from the smallest plants; which I think is not at all unlikely. I have frequently seen Chinese gardeners selecting suckers for this purpose from the plants of their gardens. Stunted varieties were generally chosen, particularly if they had the side branches opposite or regular, for much depends on this—a one-sided dwarf-tree being of no value in the eyes of the Chinese or Japanese. The main stem was then, in most cases, twisted into a zig-zag form, which process checked the flow of the sap, and at the same time encouraged the production of side branches at those parts of the stem where

they were most desired. The pots in which they were planted were narrow and shallow, so that they held but a small quantity of soil compared with the wants of the plants, and no more water was given than was actually necessary to keep them alive. When new branches were in the act of formation they were tied down and twisted in various ways; the points of the leaders and strong-growing ones were generally nipped out, and every means were taken to discourage the production of young shoots possessing any degree of vigour. Nature generally struggles against this treatment for a while, until her powers seem in a great measure to be exhausted, when she quietly yields to the power of Art. The artist, however, must be ever on the watch; for should the roots of his plant get through the pot into the ground, or happen to receive a liberal supply of moisture, or should the young shoots be allowed to grow in their natural position for a time, the vigour of the plant, which has been so long lost, will be restored, and the fairest specimen of Oriental dwarfing destroyed. It is a curious fact, that when plants, from any cause, become stunted or unhealthy, they almost invariably produce flower and fruit, and thus endeavour to propagate and perpetuate their kind. This principle is of great value in dwarfing trees. Flowering trees—such, for example, as peaches and plums—produce their blossoms most profusely under the treatment I have described; and, as they expend their energies in this way, they have little inclination to make vigorous growth.—Fortune: *Japan and China.*

THE BAMBOO AND ITS USES.

The Bamboo belongs to the natural order *Gramineæ*, or the grasses, and embraces a number of species, all of which are gigantic, tree-like, branching grasses, natives of the warmer regions of Eastern Asia, the Indian Archipelago, and tropical America. The stems are hollow, jointed, hard externally, and coated with a silicious or flinty glaze. The reed bamboo (*Bambusa arundinacea*) is perhaps the most common species. In

some districts of Further India it covers immense tracts, forming a dense jungle, and rising occasionally to the height of 40 or 50 feet (other rarer varieties rise sometimes to the height of 60 or 80 feet). It is at once majestic and elegant, and impresses upon the traveller, as much perhaps as the palm, the peculiar aspect of a tropical region. The bamboo is one of the most useful and valuable plants which the Author of nature has bestowed on the natives of the countries where it grows, and some idea of its multifarious uses may be gleaned from the following summary by Mr. Fortune in his "Journey to the Tea Districts of China:"—"Among the inhabitants of the Celestial Empire it is used for almost every conceivable purpose. It is employed in making soldiers' hats and shields, umbrellas, soles of shoes, scaffolding-poles, measuring-rods, baskets, ropes, paper, pencil-holders, brooms, sedan-chairs, pipes, flower-stakes, and trellis-work in gardens: pillows are made of the shavings; a kind of rush cloak for wet weather is made from the leaves. On the water it is used in making sails and covers for boats, for fishing-rods and fish-baskets, fishing-stakes and buoys: catamarans are rude boats, or rather floats, formed of a few logs of bamboo lashed firmly together. In agriculture the bamboo is used in making aqueducts for conveying water to the land; it forms part of the celebrated water-wheel, as well as of the plough, the harrow, and other implements of husbandry. Excellent water-pipes are made of it for conveying springs from the hills, to supply houses and temples in the valleys with pure water. Its roots are often cut into the most grotesque figures, and its stems finely carved into ornaments for the curious, or into incense-burners for the temples. The Ningpo furniture, the most beautiful in China, is often inlaid with figures of people, houses, temples, and pagodas in bamboo—which form most correct and striking pictures of China and the Chinese. The young shoots are boiled and eaten, and sweetmeats are also made of them, whilst the seeds are sometimes used instead of rice, and a tolerably good bread is made of them. A white silicious secretion found in the joints, and called *tabasheer*, is employed in

medicine. In the manufacture of tea it helps to form the rolling-tables, drying-baskets, and sieves; and last, though not least, the celebrated chop-sticks—the most important articles in domestic use—are made of it.

"However incredulous the reader may be, I must still carry him a step further, and tell him that I have not enumerated one-half of the uses to which the bamboo is applied in China. Indeed, it would be nearly as difficult to say what it is *not* used for, as to tell for what it is. It is in universal demand, in the houses and in the fields, on water and on land, in peace and in war. Through life the Chinaman is almost dependent upon it for his support, nor does it leave him until it carries him to his last resting-place on the hill-side; and even then, in company with the cypress, the juniper, and the pine, it waves over and marks his tomb."

VIRGIN FORESTS OF BRAZIL.

The whole length of the road is through one dense forest, the magnificence of which cannot be imagined by those who have never seen it nor penetrated into its recesses. Those remnants of the virgin forest which still stand in the vicinity of the capital (Rio Janeiro), although they appear grand to the eye of a newly-arrived European, become insignificant when compared with the mass of giant vegetables which clothes the sides of the Organ Mountains. So far as I have been able to determine, the large forest trees consist of various species of palms, laurels, figs, cassias, bignonias, solanums, myrtles, and melastoms. In temperate climates natural forests are mostly composed of trees that grow gregariously. In those of tropical countriés it is seldom that two trees of a kind are seen growing together, the variety of different species is so great. Many of the trees are of immense size, and have their trunks and branches covered with myriads of those plants which are usually called *parasites*, but are not so in reality, consisting of orchids, bromelias, ferns, peperomiæ, &c., which derive their nourishment from the moisture of the bark,

and the earthy matter that has been formed from the decay of mosses, &c. Many of the trees have their trunks encircled by twiners, the stems of which are often thicker than those they surround. This is particularly the case with a kind of wild fig, called by the Brazilians "cipo-matador." It runs up the tree to which it has attached itself, throwing out from each side, at the distance of about every ten feet, a thick clasper, which curves round and closely entwines the stem. As both the trees increase in size, the pressure becomes so great that ultimately the supporting one dies from the embrace of the parasite.

There is another kind of wild fig-tree, with an enormous height and thickness of stem, to which the English residents give the name of "buttress trees," from several large thin plates which stand out from the bottom of the trunk. They begin to jut out from the stem at the height of ten or twelve feet from the bottom, and gradually increase in width till they reach the ground, where they are connected with the large roots of the tree. At the surface of the ground these plates are often five feet broad, and throughout not more than a few inches thick. The various species of laurel form fine trees. They flower in the months of April and May, at which season the atmosphere is loaded with the rich perfume of their small white blossoms. When their fruit is ripe, it forms the principal food of the jacutinga, a fine large game-bird. The large cassias have a striking appearance when in flower; and as an almost equal number of large trees of lasiandra and others of the melastoma tribe are in bloom at the same time, the forests are then almost one mass of yellow and purple from the abundance of these flowers. Rising amidst these, the pink-coloured flowers of the *Chorisia speciosa*—a kind of silk-cotton tree—can be easily distinguished. It is also a large tree with a stem from 5 to 8 feet in circumference, covered with strong prickles, and unbranched to the height of 30 or 40 feet. The branches then form a nearly hemispherical top, which, when covered with its thousands of beautiful large rose-coloured blossoms, has a striking effect, when contrasted with the masses of green, yellow, and purple of the surrounding trees.

Many of these large trunks afford support to various species of climbing and twining shrubs, belonging to the natural orders *Bignoniaceæ*, *Compositæ*, *Apocyneæ*, and *Leguminosæ*, the stems of which frequently assume a very remarkable appearance. Several of them are often twisted together, and dangle from the branches of the trees like large ropes, while others are flat and compressed like belts: of the latter description I have met with some six inches broad and not more than an inch thick. Two of the finest climbers are the beautiful large trumpet-flowered *Solandra grandiflora*, which, diffusing itself among the largest trees of the forest, gives them a magnificence not their own; and a showy species of *Fuchsia*, which is very common, attaching itself to all kinds of trees, often reaching to the height of 60 or 100 feet, and then falling down in the most beautiful festoons.

At the foot of the mountains the underwood principally consists of shrubs belonging to the natural orders *Melastomaceæ*, *Myrticeæ*, *Compositæ*, *Solanaceæ*, and *Rubiaceæ*, among which are many large species of herbaceous ferns and a few palms. About the middle, palms and tree-ferns abound, some of the latter reaching to a height of not less than 40 feet. These trees are so unlike every other denizen of the forest, so strange in appearance, and yet so graceful, that they have always attracted my attention more than any others, not even excepting palms. At an elevation of about 200 feet, a large species of bamboo (*Bambusa Tagdeora*) makes its appearance. The stems of this gigantic grass are often 18 inches in circumference, and attain a height of from 50 to 100 feet. They do not, however, grow perfectly upright, their tops forming a graceful curve downwards. Throughout the whole distance, the path was lined on each side with the most beautiful herbaceous plants and delicate ferns.—GARDNER'S *Travels in the Interior of Brazil.*

THE RICE-PAPER PLANT.

UPON the hills in the neighbourhood of Tam-suy, in Formosa, grows in considerable abundance the rice-paper plant (*Aralia*

papyrifera); and thence it is largely imported into China, for the purpose of making upon the prepared paper those brilliant colourings for which the Chinese are so renowned. It is a small but elegant plant, the stem growing to the height of from four to six feet, and then giving off by long foot-stalks a number of handsome, large, digitated leaves of a dark-green colour, but whitish beneath, which spread out sometimes four or five feet on either side. For a long time the source of rice-paper was a mystery, and its name indicates the common fallacy as to its origin; but an examination with the microscope could not fail to detect the large cellular substance of which it is really composed, namely, the altered pith of a plant. This pith is of a snowy whiteness, and occupies the whole of the cylindrical stem, more particularly at its upper portion, becoming smaller near the base. I never found any hollow centre in the pith, although it is said the Chinese themselves call it the *tung-tsau* or hollow plant; nor did I observe any specimens in the neighbourhood of Tam-suy more than six feet high, although the Chinese accounts make it thrice that height. Probably the specimens which came under my notice were young, or those which had not had the benefit of cultivation, for they were scattered sporadically (that is, without order, hither and thither) upon the hill sides. The mode of preparing the paper from this plant is by skilfully paring the previously-removed pith with a broad and sharp knife, which shaves it cleanly off in a spiral manner from the circumference to the centre, at the same time preserving an equable thickness throughout. The substance is then flattened out, cut into smooth sheets, and is ready for the reception of the pigment, which can be laid on with remarkable facility and brilliancy.—COLLINGWOOD: *Naturalist's Rambles in the Chinese Seas.*

THE MAMMOTH-TREE GROVE OF CALIFORNIA.

THE Mammoth-tree Grove is situated in a gently-sloping and heavily timbered valley on the watershed or ridge between the

San Antonio branch of the Calaveras River and the north fork of the Stanislaus River, in lat. 38° north, and long. 120° 10′ west; at an elevation of 4370 feet above the sea, and at a distance of ninety-seven miles from Sacramento city and eighty-seven from Stockton.

When specimens of the wood of this tree, with its cones and foliage, were sent to England for examination, Professor Lindley, an eminent English botanist, considered it as forming a new genus, and accordingly named it *Wellingtonia gigantea;* but through the examinations of Mr. Lobb, a gentleman of rare botanical attainments, who has spent several years in California, devoting himself to this interesting, and, to him, favourite branch of study, it has been decided to belong to the Taxodium family, and must be referred to the old genus *Sequoia sempervirens.* Not being a new genus, it is now generally known among men of science as *Sequoia gigantea*, though still popularly called *Wellingtonia*—or, as some good and laudably patriotic souls in the New World would have it (to prevent the English stealing American thunder), *Washingtonia gigantea.*

Within an area of fifty acres, there are one hundred and three trees of goodly size, twenty of which exceed 25 feet in diameter at the base, and consequently are about 75 feet in circumference! Let us take a survey of these giants of the forest, and, first, of the "Big-Tree Stump," upon whose perfectly smooth, sound, and level floor we now stand:—

Upon this stump, however incredible it may seem, on the 4th of July (Independence day), thirty-two persons were engaged in dancing at one time, without suffering any inconvenience; and besides these the accompanying musicians and some lookers-on. Across the solid wood of this stump, five and a half feet from the ground (the bark is now removed, which was from 15 to 18 inches thick), the diameter is 25 feet, and, with the bark, it must have been between 27 and 28 feet. Think for a moment: the stump of a tree exceeding *nine yards* in diameter, and sound to the very centre!

In felling this tree five men were occupied for twenty-two

days, not by chopping it down, but by *boring it off* with pump augers. After the stem was fairly severed from the stump, the uprightness of the tree and the breadth of its base sustained it in its position. To accomplish the feat of throwing it over, two and a half days of the twenty-two were spent in inserting wedges, and driving them in with the butts of trees, until, at last, the noble monarch of the forest was forced to tremble, and then to fall, after braving "the battle and the breeze" of nearly three thousand winters. In our estimation it was a sacrilegious act; although it is possible that the exhibition of the bark among the unbelievers of the eastern part of our own continent, and of Europe, may have convinced all the "Thomases" living that we have great facts in California that must be believed sooner or later. This is the only palliating circumstance with us for an act of irreverence and desecration. This noble tree was 302 feet in height, and 96 in circumference at the ground. Upon the upper part of the prostrate trunk is constructed a long double bowling-alley, where the athletic sport of playing bowls may afford a pastime and change to the visitor.

Now let us walk among the giant shadows of the forest to another of these wonders—the largest tree now standing, which, from its immense size, two breast-like protuberances on one side, and the number of small trees of the same class adjacent, has been named the "Mother of the Forest." In the summer of 1854 the bark was stripped from this tree by Mr. George Gale, for the purpose of exhibition in the East (the New England States), to the height of 116 feet; and it now measures in circumference at the base (without the bark) 84 feet; twenty feet from base, 69 feet; seventy feet from base, 63½ feet; one hundred and sixteen feet from base, and up to the bark, 39½ feet! Its full circumference at base, including bark, was 90 feet, and its height 321 feet. The average thickness of the bark was 11 inches, although in some places it was nearly double that amount; and its first persistent branch was 137 feet from the ground.

A short distance from the above lies the prostrate and majestic body of the "Father of the Forest" the largest of the entire

group, half buried in the soil. This tree measures in circumference at the roots 110 feet. It is 200 feet to the first branch. The trunk to this point being hollow, the tallest person can walk through it erect. By the trees that were broken when this giant trunk bowed its proud head and fell, it is estimated that, when standing, its entire height could not have been less than 435 feet! Three hundred feet from the roots, and where it was broken off by striking against another tree, it is 18 feet in diameter. Around this tree stand the graceful yet giant trunks of numerous other trees, which form a family circle, and make this the most imposing scene in the forest; and no doubt from this circumstance, and its immense size, originated the name.

Let us not linger here too long, but pass on to the "Husband and Wife"—a graceful pair of trees that are leaning with apparent affection against each other. Both of these are of the same size, and measure in circumference, at the base, about 60 feet, and in height about 252 feet. A short distance further is the "Burnt Tree," which is prostrate, and hollow from numerous burnings, and in which a person can ride on horseback for sixty feet. The estimated height of this tree, when standing, was 330 feet, and its circumference 97 feet. It now measures across the roots 39½ feet.

"Hercules," another of the giants, is 95 feet in circumference, and 320 feet high. The "Hermit," a lonely fellow, is 60 feet in circumference, and 318 feet high; exceedingly straight and well-formed. The "Old Maid"—a stooping, broken-topped, and forlorn-looking spinster of the Big-Tree family—is 261 feet in height, and 59 in circumference. As fit companion to the above, though at a respectful distance, stands the dejected-looking "Old Bachelor." This tree, as lonely and as solitary as the former, is one of the roughest, bark-rent specimens of the Big Trees to be found. In size it has rather the advantage of the "Old Maid," being 298 feet in height, and 60 in circumference. Near to the "Old Bachelor" is the "Pioneer's Cabin," the top of which is broken off about 150 feet from the ground. This tree measures 39 feet in diameter, but as it is hollow and uneven in the surface, its average size is not quite equal to that.

The "Siamese Twins," as their name indicates, with one large stem at the ground, form a double tree about 41 feet upward—each of the forks being 300 feet high. Near to them stands the "Guardian," a fine-looking old tree 320 feet high, and 81 in circumference. The "Mother and Son" form another beautiful sight, as side by side they stand. The former is 315 in height, and the latter 302. The "Horseback Ride" is an old, broken, and long prostrate trunk, 150 feet in length, hollow from one end to the other, and in which, to the distance of seventy-two feet, a person can ride on horseback. At the narrowest place inside the diameter is 12 feet. "Uncle Tom's Cabin" is another fanciful name given to a tree that is hollow, and in which twenty-five persons can be seated comfortably. This tree is 305 feet high, and 91 in circumference. The "Pride of the Forest" is one of the most beautiful trees of this wonderful grove. It is well shaped, straight, and sound; and though not quite so large as some of the others, is nevertheless a noble-looking member of the community, 275 high, and 60 in circumference.

The "Beauty of the Forest" is similar in shape to the preceding, and measures 307 feet in height and 65 in circumference. The "Two Guardsmen" stand by the roadside at the entrance of the "clearing," and seem to be the sentinels of the valley. In height they are about 300 feet, and in circumference one is 65 feet and the other 69. Next—though last in being mentioned, not least in gracefulness and beauty—stand the "Three Sisters," or, as some call them, the "Three Graces," one of the most beautiful groups (if, indeed, not *the* most beautiful) in the whole assemblage. In height they are nearly equal, being about 295 feet, and their average circumference at the base is 90 feet.

Many of the largest of these trees have been deformed and otherwise injured by the numerous and large fires that have swept with desolating fury over this forest at different periods. Very little decayed timber, however, is to be seen; the *Sequoia*, like others of the same family, being less subject to decay, even when fallen and dead, than most other woods. Respecting the age of this grove there has been but one opinion among the best-

informed botanists, which is this—that each concentric layer of wood is the growth of a single year; and as nearly three thousand concentric circles can be counted in the stumps of several of these trees, it is correct to conclude that they are nearly three thousand years old. Could these magnificent and venerable giants of Calaveras County be gifted with a descriptive historical tongue, how their recital would startle us, as they told of the many wonderful changes that have taken place in California within the last three thousand years!—*Abridged from* HUTCHING'S *Scenes and Wonders in California.*

COFFEE-GROWING IN BRAZIL.

WITH the exception of the house-enclosure and the garden with its aviary and fish-pond, all the property (the *fazenda* or farm of Fortaleza) which is not forest is devoted to coffee, covering all the hill-sides for miles around. The seed is planted in nurseries specially prepared, where it undergoes its first year's growth. It is then transplanted to its permanent home, and begins to bear in about three years, the first crop being of course a very light one. From that time forward, under good care and with favourable soil, it will continue to yield two crops or more annually for thirty years in succession. At the end of that time the shrubs and the soil are alike exhausted, and, according to the custom of the country, the *fazendeiro* cuts down a new forest and begins a new plantation, completely abandoning his old exhausted land. One of the long-sighted reforms undertaken by our host is the manuring of the old deserted plantations on his estate. He has a number of young vigorous plantations, which promise to be as good as if virgin forest had been sacrificed to produce them. He wishes not only to preserve the wood on his estate, and to show that agriculture need not be cultivated at the expense of taste and beauty, but to remind his countrymen, also, that extensive as are the forests they will not last for ever, and that it will be necessary to emigrate before long to find new

coffee-grounds, if the old ones are to be considered worthless. Another of his reforms is that of the roads—having substituted for the old, steep, rain-gullied tracks, winding roads in the side of the hill, with a very gradual ascent, so that light single-mule carts can transport all the harvests from the summit of the plantations to the drying-grounds. . . . .

It was the harvesting season, and the spectacle was a pretty one. The negroes, men and women, were scattered about the plantations with broad, shallow trays, made of plaited grass or bamboos, strapped over their shoulders and supported at their waists. Into these they were gathering the coffee, some of the berries being brilliantly red, some already beginning to dry and turn brown, while here and there was a green one, not yet quite ripe, but soon to ripen in the scorching sun. Little black children were sitting on the ground and gathering what fell under the bushes, singing at their work a monotonous but rather pretty snatch of song, in which some took the first and others the second, making a not inharmonious music. As their baskets were filled they came to the *administrador* to receive a little metal ticket on which the amount of their work was marked. A task is allotted to each one—so much to a full-grown man, so much to a woman with children, and so much to a child; and each is paid for whatever may be done over and above it. The requisition is a very moderate one, so that the industrious have an opportunity of making a little money independently. At night they all present their tickets, and are paid on the spot for any extra work. From the harvesting-ground we followed the carts down to where the burden is deposited.

On their return from the plantation the negroes divide the day's harvest, and dispose it in little mounds on the drying-ground. When pretty equally dried, the coffee is spread out in thin even layers over the whole enclosure, where it is baked for the last time. It is then hulled by a very simple machine, in use on almost all the *fazendas*. The process of preparation is now complete, the berry being ready for home use or for exportation.

To this notice, from " A Journey in Brazil by Professor and

Mrs. Louis Agassiz," it may be added that the plant which yields the coffee of commerce is the *Coffea Arabica*—a pretty evergreen shrub, varying from fifteen to twenty feet high. The flowers are white, with a rosy tint, and have an odour of the jasmine. The fruit is a succulent berry about the size of a cherry, and contains two seeds of a hard consistence, which are known as the "coffee beans." The tree is a native of Upper Ethiopia, where it has been known from time immemorial, and whence it has been disseminated into all the warmer and cultivated regions of the globe. The quantity annually raised in Arabia, East and West Indies, South America, and other coffee-producing countries, is estimated at not less than 260,000 tons.

CAOUTCHOUC AND CAOUTCHOUC TREES.

Caoutchouc, gum-elastic, or India-rubber, now so extensively used in the arts, is one of the products of the wonderful chemistry of Nature, being found in the milky juices of plants, and most abundantly in the natural orders *Moraceæ*, *Artocarpaceæ*, *Euphorbiaceæ*, and *Apocynaceæ*. It exists in the milky juice of plants growing in temperate climates, but it is only in tropical and subtropical countries that it occurs so abundantly as to be of economical importance. In the milky juice the caoutchouc is diffused in the form of minute globules, and not, strictly speaking, in solution; and when the juice is extracted from the plant and allowed to stand for a short time, these globules separate from the watery part of it and form a sort of cream on the top. The first specimens of caoutchouc seen in Europe were brought from the East Indies; but its nature and properties were not fully known till it was discovered in abundance in South America about the year 1735. It was first known as *elastic gum*, but soon received the name of *India-rubber*, from the discovery of its use for rubbing out black lead pencil-marks, for which purpose it began to be imported into Britain about the end of last century. It was not till 1820 that its employment began to extend beyond

rubbing out of pencil-marks—its application to the manufacture of waterproof cloth first giving it commercial importance. Its elasticity and flexibility, its insolubility in water, and its great impenetrability to gases and fluids in general, have now been found to adapt it to a great variety of uses. In one state or another, it is spread in thin layers to make waterproof cloth; it is cut into threads to give elasticity to articles of dress; pipes for conveying gas are made of it, as well as pipes for fire-engines; cylinders for the use of letter-press and calico printers; cushions for billiard-tables; buffers for railway carriages; rings for the stoppers of bottles to render them air-tight; a varnish useful for many purposes, and an almost endless variety of other articles. It is also employed in combination with sulphur to form *vulcanized India-rubber*, the uses of which are fully as numerous and as important as those of caoutchouc itself.

The caoutchouc of commerce is obtained chiefly from the East Indies and from South America. That of the East Indies is in a great part the produce of a species of fig (*Ficus elasticus*), often called the India-rubber tree, which grows in great abundance on rocky declivities in the forests of Sylhet, and is now, perhaps, one of the most common ornaments of British hot-houses. In its native country it becomes a tree of great size; and its large, oval, thick, glossy leaves make it an object of great beauty. Its fruit is small and uneatable. It grows with very great rapidity. The milky juice is extracted by making incisions through the bark down to the wood, completely round the trunk or branch, and at distances of a foot from each other. The juice is acrid and tenacious, and yields about a third of its weight of solid caoutchouc. Other species of fig also yield caoutchouc, particularly the sacred fig of India (*Ficus religiosa*); and the *Urceola elastica*, which grows in the island of Sumatra, produces it not only in great abundance, but of the finest quality. The caoutchouc of South America is obtained chiefly from the *Siphonia elastica*, also knowm as *Hevea caoutchouc*. This tree is common in the forests of Guiana and Brazil, and has been introduced into the West Indies. It has a trunk from 50 to 60 feet high, scaly,

very straight, and branched only at the summit. The milky juice is obtained by incisions through the bark; and the natives make clay moulds, often pear-shaped or like small bottles, which they smear with the juice and then dry in smoke, so as to impart to the caoutchouc a black colour. Successive layers of juice are applied and dried, until a sufficient thickness is attained. The caoutchouc which is obtained from the East Indies is generally in junks and balls, and is light in colour, owing to its being dried by the sun instead of over a fire as in South America. When the layers are sufficiently united the clay or other mould is broken, and the *bottle or ball India-rubber* is fit for immediate use, and is preferred in this state for some purposes. But the layers are often imperfectly united, and impurities are occasionally found to have been fraudulently introduced between them to increase the weight. Among other trees yielding caoutchouc are species of *Collophora* and *Cameraria* in South America; and *Vahea gummifera* in the island of Madagascar.—*Compiled.*

SPRING PHENOMENA OF PLANT LIFE.

A beautiful vernal phenomenon is seen in the way in which different leaves are folded up in the buds. This—which is called from the season the *vernation* of leaves (Lat. *vernus*, of or belonging to the spring)—may be well observed by cutting across the buds with a sharp knife. The vernation will be found to be very different in different genera of plants. In some the edges of the leaves will be rolled inwards, in others outwards; some will be folded alternately within each other; some will be rolled completely round; and others will be plaited like a closed fan. In ferns the vernation is very beautiful, the whole frond, and every branch of the frond, even to its minutest segment, being rolled inwards. It is called "circinate;" and it is a method of vernation which, with a very few remarkable exceptions, is confined to the tribe of ferns, and in them is so fully carried out that even the spore cases at the back of the leaves have a circinate form.

The way in which the delicate young leaves are protected in the bud cannot fail to strike us as being very beautiful and effectual. Generally, a number of dry, tough scales, grow either around them or amongst them, the edges of which overlap each other, like slates on a house, forming a complete case round the embryo leaves. The surface of these scales is generally highly polished, so that the rain runs off them without penetrating; and often they are coated with a resinous varnish, which makes them still more impervious. The scales are in many cases the stipules of the enclosed leaves. Watch the expansion of a bud of the lime-tree, and you will see this very plainly. The progress of the bud is very beautiful as each pair of stipules unfolds, and the young leaf to which they are attached is liberated. The scales grow with the leaves for a few days, and then fall off, being of no further use.

Now examine a bud of a beech-tree as it expands, and you will see how each leaf is embedded in a soft cushion of silky hairs. Not many days elapse ere the hairs fall off the young leaves, showing that they serve some purpose within the bud that is not required by the mature leaves. The hairs in beech and other buds are, doubtless, intended for the protection of the young leaves, either by supplying warmth, or to attract moisture or electricity, or perchance to prevent the closely-packed young leaves from injuring each other; but in whatever way they act, we may be quite sure they act beneficially.

In some of the earliest of the spring flowers we see a number of special contrivances, if we may so call them, to insure the protection of the seed. The coltsfoot, which flowers in February, and ripens its seed very quickly, at a time when the weather is generally very inclement, is a beautiful illustration of this. The seeds of this plant, as of all other composite plants, are naked, or rather the thin capsule becomes part of the seed, and the latter has not the protection of a seed vessel, and is therefore still more likely to be injured. When, however, the flower has opened to the sunshine, and the stamens have shed their pollen, and the flowerets begin to wither, the involucre closes tightly on the

young downy seeds, completely concealing them; but not only so, the flower-head, erect hitherto, bends downwards, so that the scales of the involucre form a beautiful canopy over the delicate seeds, and thoroughly protect them. Thus they grow and swell till they are ripe, or nearly so; when, lo, another wonder! The stalk again becomes erect, and the ripened seeds are again exposed to the air and sunshine. The feathery down is soon dried, and the wind blows the seeds away, and sows them on new ground.

The strawberry-leaved potentilla is one of the very earliest of flowers, and its seeds, like those of the coltsfoot, are apparently naked. But as soon as the petals have fallen, the double calyx closes again, and the seeds are safely shut up, as if in a bud or a seed vessel; besides which, the plant is not only an early bloomer, but it flowers all through the summer, so that if the early seeds are injured, the later ones are sure to ripen. Another very early flower is the lesser celandine, which propagates to such an extent by offsets that it apparently matters very little whether any seed ripen or not. Gorse flowers as early as January, but its seeds are protected at first by the velvety texture of the carpel, and afterwards by the hardness of the pod; besides which, though flowering so early, the seeds do not ripen till late.

The economy of the crocus is very beautiful. If a flower be examined, there is apparently no ovary at all; but, in reality, the part which we take for the stalk is the tube of the flower, and its base, containing the ovary, is close upon the top of the bulb: so, deeply buried in the ground, and safe from all the changes of the weather, the seed is being matured, until, after the coldest weather is over, it pushes its way upwards, and appears above the surface, where the process of ripening is soon finished by the influence of the warm sunshine of May.

Some of the earliest of the spring flowers come out a long while before the leaves. A beautiful yellow jasmine mezereon, many willows, many plums, almonds, peaches, and apricots, are all of this class; whilst the colchicum and the autumn crocus flower so *very* early that they are waking up when others are

going to rest, their spring-time being in the autumn. The reason of these plants flowering before they are in leaf is not very apparent. Possibly they would not have time to mature their seeds unless fertilized thus early; possibly their flowers require a full glare of light, and would be injured by any shadow from leaves. But whatever be the reason of their peculiar economy, they supply bees and other insects with early food, when food is especially wanted by them; and perhaps, after all, this may be just the reason why the good Creator, mindful of the least of His creatures, has given them these unusual habits.—*Abridged from Science Gossip.*

THE POTATO.

The Potato (*Solanum tuberosum*) belongs to the natural order Solanaceæ, and is closely related to the tobacco plant, belladonna, henbane, nightshade, and other poisonous narcotics. But although the same poisonous principle exists in the potato plant, it is confined to its stem, foliage, and fruit, and is wholly absent from its roots or underground tubers, the parts of the plant used as food. When potatoes still attached to the growing plant become exposed to the light, the epidermis assumes a greenish colour, and the poisonous principle then develops itself. Such potatoes are totally unfit for human food. The potato plant has a stem from one and a half to two feet high, with interrupted pinnate leaves, which are composed of from five to seven pairs of lanceolate oval leaflets, having lesser ones between them: the flowers are bluish-white, with orange-yellow, slightly cohering anthers; which are succeeded by a green globose berry, about half an inch in diameter. The tubers or potatoes produced by the plant are simply subterranean branches, arrested and thickened in their growth, in place of being elongated. The common idea, that all the subterranean portions of a plant are roots, is quite erroneous; for the production of leaf-buds is the distinguishing characteristic of a stem wherever situated; and that the tuber or potato is a true stem is proved by the eyes on its surface, which

are true leaf-buds. Hence the potato is propagated by cutting the tuber into pieces, when each piece, provided it has an eye, will grow and become an independent plant.

The potato is a native of South America, and is found in abundance wild in the mountainous regions of Chili, Peru, and the neighbourhood of Buenos Ayres. Its presence in Mexico, Virginia, and the Carolinas, where it was subsequently found, is probably not very ancient. It is thought that it may have been introduced there from South America by the first Spanish settlers. The potato was first grown by Sir Walter Raleigh, at Youghal, in Ireland, in 1586. The samples were brought from the Carolinas. The gardener who planted the tubers thought that the green potato-apples were the potatoes, and carried them to his master, expressing his great disgust at such produce. Sir Walter, pretending to sympathize, told him to dig up the useless weeds, and throw them away. The gardener, in rooting out the plants, found the true potatoes, more than a bushel of them, and hurried back to his master in a very different humour, to show him the samples and make known his discovery.

The soil and climate of Ireland are very favourable to the growth of good potatoes, and the plant appears to have rapidly grown into favour in Ireland, and was cultivated there as food long before its value was acknowledged in Great Britain. In both England and Scotland a prejudice against it existed, owing to the poisonous character of the plants of the natural order to which it belongs, and the resemblance of its flowers to those of the woody nightshade (*Solanum dulcamara*), an extremely common plant, well known to be poisonous. Almost everywhere the same prejudice prevailed, in France especially; and it was not until a time of great scarcity, during the Revolution, that its culture in that country became general.

For more than a century and a half after its cultivation by Sir Walter Raleigh in Ireland, the potato was cultivated in flower-gardens only in both England and Scotland. Even in 1725 the few potato plants in the gardens about Edinburgh were left in the same spot from year to year. No attempt was made at a

more extended culture. In 1728, however, a Scotch day-labourer, named Thomas Prentice, living near Kilsyth, Stirlingshire, carefully cultivated the potato as food, and, after supplying the wants of his own family, sold the remainder of the produce to his neighbours, who very willingly paid him his own price, being convinced by his example that potatoes were wholesome and nutritious. Prentice was frugal and industrious, and soon found himself in possession of £200—no small fortune in those days. He now sank his capital in an annuity at goodly interest, upon which he lived independently in his old age, dying in the year 1792, at the advanced age of eighty-six, having been sixty-four years a happy witness to the effects of the blessing which he had been instrumental in conferring on his country.

The potato appears to have been taken into favour much earlier in England, as appears from a report of a meeting of the Ray Society, held 18th March, 1662, when a letter was read from Mr. Buckland, a Somersetshire gentleman, recommending the planting of potatoes. This was referred to a committee, who reported favourably, and Mr. Buckland received the thanks of the Society. From this time the field-culture of the potato commenced, and rapidly extended as its excellent qualities became more known. A strange objection was made by the Puritans, who denied the lawfulness of eating potatoes because the plant was not mentioned in the Bible! Whether or no, a plant so nutritious, and whose culture is adapted to almost every soil and climate, must be regarded as amongst the choicest gifts of Providence. Our countrymen have since done ample justice to this plant: for now, wherever the Englishman seeks a home, he always strives to naturalize the potato plant; and, even when surrounded by the luxuries of tropical lands, remembers the simple vegetable which was so long struggling into notice in his own country.—H. Coultas, *in Popular Science Review.*

ZOOLOGICAL.

THE ANIMAL KINGDOM.

In whatever direction we turn our eyes, we everywhere meet the varied forms of animal life. Earth, air, and water are all alike occupied by multitudes of living creatures, each fitted especially for the habitation assigned to it by Nature. Every wood or meadow, nay, every tree or shrub or tuft of grass, has its inhabitants; even beneath the surface of the ground numbers of animals may be found fulfilling the purposes for which their species were called into existence. Myriads of birds dash through the air supported on their feathered pinions, or solicit our attention by the charming song which they pour forth from their resting-places; whilst swarms of insects, with still lighter wings, dispute with them the empire of the atmosphere. The waters, whether salt or fresh, are also filled with living organisms: fishes of many forms and varied colours, and creatures of still more strange appearance, swim silently through their depths, and their shores are covered with a profusion of polypes, sponges, star-fishes, and other animals. To whatever elevation we attain on the mountain sides, to whatever depth in the ocean we may sink the lead, everywhere shall we find traces of animal existence, everywhere find ourselves surrounded by living creatures, in a profusion and variety which may well excite our wonder and admiration.

Nor are these phenomena confined to any one region of the Earth: on the contrary, the diversity of climate only adds to the variety of objects which the zoologist is called upon to contemplate. Thus the bold voyager of the inclement regions of the north, in losing sight of those productions of nature which met

his eyes at home, finds, as it were, a new creation in his new abode—seals, by the hundred, basking in the scanty rays of the Arctic sun, or diving into the deep waters in search of their finny prey—the whale, rolling his vast bulk in the waves, and ever and anon driving high into the air his curious fountain—water, be it remembered, strained from the myriads of small animals which constitute the food of the leviathan. The air is peopled by innumerable flights of marine birds; the sea by countless swarms of fishes; and the land affords a habitation to the elk and the reindeer, the Arctic fox, and other creatures peculiar to those regions.

If we turn our regards southward, to the tropical regions of the Earth, the abundance and variety of animated beings increase more and more. Here the colossal elephant and the equally unwieldy rhinoceros crash through primeval forests; the lion and the tiger, and other predatory beasts, prowl through the thickets, seeking for their prey; on vast plains countless herds of antelopes browse in fancied security, or dash swiftly away at the approach of danger; gigantic snakes lie coiled in horrid folds amongst the bushes, or hanging from the trees await their victims. The air and trees swarm with birds of gorgeous plumage, and insects of strange forms and brilliant colours. Nor are the waters less bountifully provided with inhabitants: every form with which we are acquainted in our own seas is here represented, but with still greater profusion and variety.

At night the ocean sparkles with a brilliancy which rivals the splendour even of a tropical sky; and this phenomenon, which may be witnessed, although in an inferior degree, in more temperate climes, is due to the presence of vast multitudes of minute phosphorescent animals, whose very existence would frequently remain unknown but for their power of illuminating the waves by night.

And when we have exhausted the study of external nature, there is yet another world to which we may turn. Within our bodies, and those of every species of animal from the highest to nearly the very lowest, exist various forms of parasites, preying

upon our substance or our food; creatures whose very existence and development are a mystery—a mystery, however, which, as far as it has yet been unravelled, serves to raise our expectations as to what remains behind.

ZOOLOGICAL CLASSIFICATION.

When we consider the immense number of animals existing on the face of the Earth, of which we have endeavoured in the preceding section to give some slight idea, we are soon convinced that an attempt to obtain a knowledge of each of them individually, and without any acquaintance with their mutual relationships, would be a perfectly hopeless task. We are, in fact, compelled to call in the aid of some system of classification, which, by bringing together those animals which most resemble each other, and characterizing them by some common point of structure, may enable us to form a sort of general idea of the whole, and to remember more readily the peculiarities of each. Some such classification, rough and imperfect it may be, is indeed formed by every observant mind, and its terms find a place in ordinary language. Beasts, birds, and fishes, reptiles and insects, are words familiar to every one, and convey to the minds of those to whom they are addressed a more or less definite idea, according to the preconceived notions of the hearer.

Scientific zoological classification is, in point of fact, to a certain extent coincident with this popular classification. The latter being the result of observation—the only foundation of natural history—must necessarily be more or less correct, according to the extent to which the different kinds of animals bring themselves under the notice of mankind. Thus we find that tolerably clear notions exist as to the differences between a beast, a bird, and a fish, these being creatures that pass constantly under our eyes—although even with respect to these groups we find some erroneous ideas prevailing; but with respect to insects and other lower animals, with which mankind at large are not familiar, the classification of ordinary language is by no means so precise: so that whilst in the former cases Zoology can adopt

the peculiar groups merely by submitting them to a few modifications, in the latter Science is compelled to invent a system of her own.

This scientific classification is not, however, a mere arbitrary arrangement, like that of the words in a dictionary, with the sole object of enabling us to find out all that is known of a given animal in the shortest possible period of time: it has another and a higher purpose in view—that of showing the mutual relations of the various members of the animal kingdom, and tracing, in a manner, the steps taken by the Creator in the modification of the same type to suit the various conditions in which His creatures were to be placed.

The knowledge of species constitutes the foundation of all zoological knowledge, without which we can never arrive at sound generalizations. The *species*, which forms the first step in classification, consists of an assemblage of individual animals which are supposed all to have descended from the same parents, and which exhibit the closest possible resemblance in every part of their structure. This definition, if definition it may be called, must not, however, be taken in the strictest sense which might be applied to the words; for in many cases we find that individuals undoubtedly belonging to the same species vary considerably amongst themselves, principally in colour and size; hence the distinction of *variety*. Variation is generally to be observed, however, in animals under the influence of domestication, the individuals of most species of wild animals resembling each other so closely that it would be difficult to overlook their specific identity.

We generally find that several species exhibit a considerable amount of resemblance one to another, agreeing perhaps in most points of importance, but differing in characters of minor value, such as colour, texture, and so forth. Such groups of species constitute the second upward step in classification: they are called *genera*. Thus the horse, the ass, and the zebra, although they may readily be distinguished from each other as species, present a very close resemblance in their general structure, and

form a *genus;* the cat, the lion, the tiger, and the leopard are in the same case; as are also the dog, the wolf, the fox, and the jackal;—the animals may readily be distinguished as species, whilst the structure of their organs presents many common characters.

The arrangement of the species of animals in genera gives rise to the modern system of zoological nomenclature. This system is called the *binomial system*, from the circumstance that, according to this method, every animal receives two names; one belonging to itself exclusively, the other in common with all the other species of the genus in which it is included. For example, the genus *Felis*, or cat, includes the lion, tiger, leopard, and cat, as species; they all, accordingly, bear the generic name *Felis*, with the addition of a second name specially applied to each, serving to distinguish it from all other species of the genus: thus the lion is called *Felis Leo*, the tiger *Felis Tigris*, the leopard *Felis Leopardus*, and the cat *Felis Cattus*. This method of nomenclature has at least this advantage over the plan of conferring only a single name upon each species, that when we hear for the first time the name of a newly discovered animal, if we are at all acquainted with the genus to which it belongs, the mere mention of the name puts us at once in possession of a considerable amount of information as to its structure, form, and habits.

Proceeding with our ascending scale of classification, we find that the genera in their turn are united by some common characters of importance into *families*, and these again into *tribes*. The tribes combine to form *orders;* in some cases we meet with intervening steps, uniting the tribes belonging to one order into two or three subordinate groups. The orders in their turn group themselves into *classes;* and these lead us up to certain primary divisions, which when put together constitute the ANIMAL KINGDOM.

These great divisions are: I. The VERTEBRATA, or animals having a back-bone (Lat. *vertebræ*), which embraces the *Mammalia* or sucklers, the *Aves* or birds, the *Reptilia* or reptiles, and the *Pisces* or fishes: and, II. The INVERTEBRATA, or those not pos-

sessing a bony skeleton, and which comprehends the *Articulata* or jointed animals, like the insects, worms, and crabs; the *Mollusca* or shell-fishes; the *Radiata* or rayed animals, like the star-fishes and jelly-fishes; and lastly the *Protozoa* (Gr. first or lowest), or creatures like the sponges, infusorial animalcules, and other microscopic forms. These classes are further subdivided into orders, families, and genera, as already mentioned, and in this manner: The Tiger, for example, belongs to the order *Carnivora* (flesh-eaters), to the family *Felidæ* (cat-like animals), to the genus *Felis*, and to the species *Tigris;* its designation in scientific nomenclature being *Felis Tigris.* As with the tiger, so with other animals; the object of the arrangement being to give in the briefest form some idea of the place an animal holds, and the function it performs, in the scheme of creation. The science of ZOOLOGY (from two Greek words, *zoon*, an animal; and *logos*, discourse) when taken in its widest sense, embraces, therefore, all that relates to the structure, habits, distribution, and classification of animals;—in other words, it deals with the Animal Kingdom in all its aspects and relations, as Botany deals with the Vegetable.—*Chiefly from* DALLAS's *Natural History of the Animal Kingdom.*

SPONGES AND SPONGE GROWTH.

AT the base of the animal scale, and apparently in close connection with the vegetable kingdom, yet, when minutely examined, resembling no vegetable in organization, is found the family of Sponges, a considerable number of which inhabit the shores of the British Islands. Dr. Johnson, in his "History of the British Sponges," enumerates fifty-six species, which he groups under nine genera, distinguished from one another by characters derived from differences in the structure and mineral composition of the skeleton. The outward forms of sponges are exceedingly sportive, and even the same species, at different periods of its life or under the influence of different circumstances, often exhibits an outward aspect of very opposite character. Some are, indeed,

tolerably constant in form, especially the branching species; but the majority are shapeless, or assume a form depending in a great measure on the objects in connection with them. It thus becomes necessary, in studying the Sponges, to acquaint ourselves intimately with the exact structure of the skeleton. The spongy body is of the simplest nature. It consists of a horny or sometimes stony net-work, composed of innumerable interlacing fibres, connected together and inosculating, till a porous mass, full of holes and passages, is the result. This is the skeleton, and such is seen in the common sponges in every-day use. When the creature is alive, every portion of the horny fibre is coated over with a semi-fluid, slimy matter, like a half-consistent jelly, seemingly inert and inorganized, and yet the seat of whatever life the sponge possesses. It is by this slime, which may be pressed out with the finger, that the net-work is deposited, and from it the whole growth of the mass proceeds. The slimy substance is apparently void of sensation, for it does not shrink when wounded; and the only motion resembling animal life which the mature sponge exhibits is in the imbibition and expulsion of continuous currents of water. If any species of sponge be examined, the holes with which the substance is everywhere pierced may be seen to be of two kinds: one of a larger size than the rest, few in number, and opening into wide channels or tunnels, which pierce the sponge through its centre; the other minute, extremely numerous, covering the whole surface, and communicating with the innumerable branching passages which make the body of the skeleton. According to the observations of Dr. Grant, water is freely imbibed through the smaller holes, and continuously expelled in jets through the larger, as long as the animal retains life. These currents may be seen if a small specimen of a living sponge be placed in a watch-glass or other shallow vessel of salt water, and examined through the microscope; and it appears to be through their agency that the substance is nourished. Nourishing particles dispersed through the water are received into the universal stomach, and what is not required is ejected through the canals.

Such is the simple history of the Sponges. Their propagation is provided for in a curious manner. At certain seasons of the year, if a sponge be cut open, innumerable minute bud-like points will be found attached to the sides of the lining of the canals. These are the *gemmules* or young eggs of the sponge. As they increase in size they are gradually clothed with vibratile hairs (*cilia*), and at length, being fully formed, fall off as oval bodies; not inert like the eggs of more active animals, or like their parents, but moving freely by the perpetual vibration maintained by their cilia. These cilia, by their united action, create strong currents round the little body, which drive it forward into the stream that issues from the opening of the sponge, and thence into the open sea, where its motion is continued till it has reached a place suitable for its development. When this is done it soon attaches itself; its wanderings cease, and it commences the quiet vegetative life of its parent. The instincts which guide animals in the care of their young are among the most interesting that the lower animals exhibit; but here, at the base of the scale, we find a passive parent whose young are endowed with powers of motion denied to its mature growth, and these obviously supply, by a beautiful arrangement, the deficiencies of the mother.—Harvey: *The Sea-Side Book.*

JELLY-FISHES.

Among the animated wonders of the sea, though not all of microscopic size, few tribes are more singular in structure and in their history, or more beautiful in their varied forms, than the *Acalephæ* or Jelly-fishes, to whose phosphorescence the luminosity of the sea is chiefly attributable. Many of these creatures are of strictly microscopic size, and so transparent that they can scarcely be seen in the water in which they swim, except when revealed by the motions of their cilia, or the flashes of light which they send forth in the dark; others are of comparatively large size, and some are even three or four feet in length. The sea in all climates contains these simple creatures, and sometimes swarms with them

in countless multitudes. Even on our own coasts I have seen the shore rendered offensive for miles in extent by the stranding of shoals of minute *Medusæ*, each of which individually was scarcely bigger than a pea. But it is in tropical latitudes, and through the scarcely fathomable waters of the deep sea, that animals of this class display the greatest variety of form, and multiply in the greatest profusion. Here, too, the luminous species are of the largest size, and most brilliantly phosphorescent.

But it is difficult, even in the most glowing description, to convey an idea of the extraordinary effects produced by the presence of such countless luminous points scattered through the waters of the ocean. Sometimes the whole surface, far as the eye can stretch, seems one sheet of phosphorescent sheen; while looking down into the water close to the ship, large globes of fire are seen slowly moving along at various depths. The wake of the vessel, at the same time, displays the most vivid and varied scintillations, and the spray that breaks on her prow falls off like a shower of many-coloured sparks. One scarcely knows on which part of this wonderful display of fire-works to fix the attention. One after another attracts our gaze, and in its turn appears most beautiful. The phosphorescence is not constant; it is most vivid when the water is disturbed. Thus the passing of the vessel causes an illumination, long-continued in the wake she leaves behind; while a sudden breeze sweeping over the surface will send a stream of light far across the sea, strikingly similar to the dartings of the aurora through the realms of air. Such are some of the glories that the tropical ocean presents to us. Similar but less brilliant illuminations are witnessed on our own coasts, especially in warm evenings towards the close of summer; at which season vast multitudes of small *Medusæ* frequently swim along the shore, entering into creeks and bays, and sometimes literally converting the shallower inlets into strata of living jelly. At ordinary times many beautiful kinds may be collected by dragging a small gauze net after the boat, just below the surface of the water. In calm weather these little creatures rise to the upper strata of water, and sink again when the sea is troubled.

In structure, the *Acalephæ* or jelly-fishes are exceedingly simple, but not the less wonderful on that account. Our wonder is, indeed, the more excited when we find creatures of large size, as many of the *Medusæ* are, and endowed with considerable powers of perception, and some strength and agility, formed of a few delicate tissues filled with a fluid to all appearance not very different from sea-water. It is as if we had to investigate the structure of submarine bubbles. Take one of the largest of the race, weighing many pounds while living, and dry it. The whole contents of the body will either leak away or evaporate, and nothing will be left but some small shreds of membranous skin, forming a glistering stain on the surface of whatever object the jelly-fish was placed. The flesh is entirely composed of large cells of delicate structure, filled with a transparent fluid. But these cells are put together with the most rigid accuracy, and their arrangement is so varied that naturalists have had to distinguish numerous families and genera of jelly-fishes.

The jelly-fishes have been classed according to differences in their locomotive organs. Our most common species, referable to the Linnæan genus *Medusa* (but now comprising several distinct genera, according to the views of modern naturalists), are distinguished by an umbrella-shaped body, generally pellucid, from the centre of which, on the concave side, depends a cluster of variously fringed and lobed vessels, which constitute the digestive system of the animal, while numerous slender fibres or tentacula hang from the border of the umbrella-shaped disc. Such a creature resembles an expanded mushroom, with its gills and stalk. Sometimes the stalk is reduced to a minute point, and there are very many modifications. The motion in all jelly-fishes of this shape is accomplished by alternate contractions and expansions of the umbrella, repeated at regular intervals, something like the movement of the lungs in respiration—in allusion to which resemblance this order of jelly-fishes has been called *Pulmonigrade*. The convex side of the umbrella is directed forward, the fimbriated vessels and tentacula stream behind, and the creature is propelled with a steady and graceful motion, very rapid in some species.

Unsightly and repulsive as the jelly-fish looks when stranded and lying exposed among sea-wrack on shore, it is a most beautiful animal when expanded in its native element and moving along in freedom. Nor is it so defenceless as its low organization and the softness of its parts may lead us to suppose. Many of the species are capable of inflicting a sharp and painful sting, sufficiently strong to paralyze the animals on which they prey, or perhaps to ward off danger when attacked by superior foes; while the long tentacles with which most of them are furnished are admirably adapted for seizing prey, as they adhere to whatever comes within their reach.—HARVEY: *The Sea-Side Book.*

THE LAND-LEECH OF CEYLON.

OF all the plagues which beset the traveller in the rising grounds of Ceylon, the most detested are the land-leeches (*Haemadipsa Ceylanica*). They are not common in the plains, which are too hot and dry for them; but amongst the ground vegetation on the lower ranges of the hill-country, which is kept damp by frequent showers, they are found in tormenting profusion. They are terrestrial, never visiting ponds or streams. In size they are about an inch in length, and as fine as a common knitting-needle; but capable of distension till they equal a quill in thicknes sand attain a length of nearly two inches. Their structure is so flexible that they can insinuate themselves through the meshes of the finest stocking, not only seizing on the feet and ankles, but ascending to the back and throat, and fastening on the tenderest parts of the body. The coffee-planters, who live among these pests, are obliged, in order to exclude them, to envelop their legs in "leech-gaiters" made of closely-woven cloth. The natives smear their bodies with oil, tobacco ashes, or lemon juice; the last serving not only to stop the flow of blood, but to expedite the healing of the wounds. In moving, the land-leeches have the power of planting one extremity on the earth and raising the other perpendicularly, to watch for their victim.

Such is their vigilance and instinct, that, on the approach of a passer-by to a spot which they infest, they may be seen amongst the grass and fallen leaves on the edge of a native path, poised erect, and preparing for their attack on man and horse. On descrying their prey, they advance rapidly by semi-circular strides, fixing one end firmly and arching the other forward, till by successive advances they can lay hold of the traveller's feet, when they disengage themselves from the ground and ascend his dress in search of an aperture to enter. In these encounters the individuals in the rear of a party of travellers in the jungle invariably fare worst, as the leeches, once warned of their approach, congregate with singular celerity. Their size is so insignificant, and the wound they make is so skilfully punctured, that both are generally imperceptible, and the first intimation of their onslaught is the trickling of the blood or a chill feeling of the leech when it begins to hang heavily on the skin from being distended by its repast. Horses are driven wild by them, and stamp the ground in fury to shake them from their fetlocks, to which they hang in bloody tassels. The bare legs of the palankin-bearers and coolies are a favourite resort. The hands of these being too much engaged to be spared to pull them off, the leeches hang like bunches of grapes round their ankles; and I have seen the blood literally flowing over the edge of a European's shoe from their innumerable bites! In healthy constitutions the wounds, if not irritated, generally heal, occasioning no other inconvenience than a slight inflammation and itching; but in those with a bad state of body, the punctures, if rubbed, are liable to degenerate into ulcers, which may lead to the loss of the limb or the life. Both Marshall and Davy mention, that during the march of troops in the mountains, when the Kandyans were in rebellion in 1818, the soldiers, and especially the Madras sepoys, with the pioneers and coolies, suffered so severely from this cause that numbers of them perished.

One circumstance regarding these land-leeches is remarkable and unexplained: they are helpless without moisture, and in the hills where they abound at all other times they entirely dis-

appear during long droughts—yet appear instantaneously on the very first fall of rain, and in spots previously parched, where not one was visible an hour before. A single shower is sufficient to reproduce them in thousands, lurking beneath the decaying leaves, or striding with rapid movements across the gravel. Whence do they re-appear? Do they, too, take a "summer sleep," like the reptiles, molluscs, and tank-fishes; or may they be, like the *Rotifera*, dried up and preserved for an indefinite period, resuming their vital activity on the mere recurrence of moisture?—TENNENT'S *Ceylon*.

UTILITY OF THE EARTH-WORM.

"THE most insignificant insects and reptiles are of much more consequence," says White, in his delightful "Natural History of Selborne," "and have much more influence in the economy of Nature, than the incurious are aware of; and are mighty in their effects, from their minuteness, which renders them less an object of attraction; and from their numbers and fecundity. Earth-worms, though in appearance a small and despicable link in the chain of Nature, yet, if lost, would make a lamentable chasm. For to say nothing of half the birds, and some quadrupeds, which are almost entirely supported by them, worms seem to be the great promoters of vegetation, which would proceed but lamely without them. By perforating and loosening the soil, they render it pervious to the rain and to the fibres of plants; and by drawing straws and stalks of leaves into it, and especially by throwing it up in coils called *worm-casts*, they fertilize it—for that matter, being their excrement, is a fine manure for grain and grasses. Worms probably provide new soils for hills and slopes where the rain washes the earth away; and they affect slopes, probably, to avoid being flooded. Gardeners and farmers express their detestation of worms; the former, because they render their walks unsightly, and make them much work; and the latter, because (as they think) worms eat their green corn. But those men

would find that the earth without worms would soon become cold, hard-bound, and void of fermentation, and consequently sterile. Besides, in favour of worms it should be hinted, that green corn, plants, and flowers are not so much injured by them as by many species of beetles and flies in their larval or grub state, and by unnoticed myriads of small shell-less snails, called slugs, which silently and imperceptibly make amazing havoc in the field and garden."

More recently, Mr. Darwin has shown, in a paper read before the Geological Society of London, that worm-casts, which so annoy the gardener by defacing his smooth-shaven lawns, are of no small importance to the agriculturist, and that this despised creature is not only of great service in loosening the earth, and rendering it permeable by air and water, but is also a most active and powerful agent in *adding to the depth of the soil*, and in covering comparatively barren tracts with a superficial layer of fertile mould. His attention had been directed to several fields at Maer Hall in Staffordshire, some of which had, a few years before, been covered with lime, and others with burned marl and cinders, which substances in every case are now buried to the depth of several inches below the turf, just as if (as the farmers believe) the particles had worked themselves down. After showing the impossibility of this supposed operation Mr. Darwin affirms that the whole is due to the digestive process by which the common earth-worm is supported; since, on carefully examining between the blades of grass in the fields above mentioned, he found there was scarcely a space of two inches square without a little heap of cylindrical castings of worms—it being well known that worms swallow the earthy matter, and that having separated the nutritive portion, they eject at the mouths of their burrows the remainder in little intestine-shaped heaps. The same observer notices a still more remarkable instance of this kind, in which, in the course of eighty years, the earth-worm had covered a field, then manured with marl, with a bed of fine rich mould, averaging thirteen inches in depth!

PLANT-LICE AND HONEY-DEW.

THE true *Aphides*, or plant-lice, are well known to infest the early buds of the rose-tree and other plants, upon which they continue to multiply during the whole of summer. The habits and economy of these singular insects are so well known, that we shall here chiefly confine our remarks to their external characters and their general history. The body is thick, fat, and round, having, towards the end, three horn-like bristles, one of which is on each side, the other at the vent: these terminate in a little knob, and are movable; their use, however, does not appear to have been detected. The head and eyes are very small—the latter prominent; while the antennæ, unlike those of all the other families, are as long as the body, slender, filiform, and composed of seven joints. The wings also differ greatly from all other hemipterous insects: they are perfectly transparent, and distinctly veined—assimilating, in short, to those of the hymenopterous order. Like those insects, they have likewise the power of forming a honey-like secretion from the vegetable juices upon which they subsist, although by a totally different process. In most species of the aphides, both males and females acquire wings at certain seasons: but in this respect they are subject to great variation; there being some males and some females that never have wings; and some females that become winged, while others of the same species do not. The aphides are the most defenceless of all insects, for they can neither fly nor run sufficiently fast to avoid danger: they seem never to make use of their wings but for the purpose of finally leaving the little society in which they were born and establishing for themselves a distinct colony; while the feet, although perfect, are remarkably slender, and only enable the animal to walk very slowly.

The Honey-dew, according to the observations of the late Mr. Curtis, is chiefly, if not entirely, produced by these insects. "Were a person," observes our ingenious author, "to take up a book in which it was gravely asserted that in some countries

there were certain animals which voided liquid sugar, he would soon lay it down, regarding it as a fabulous tale, calculated to impose on the credulity of the ignorant; and yet such is literally the truth. The superior size of the *Aphis salicis*, or willow-plant-sucker, will enable the most incredulous observer to satisfy himself on this head. On looking steadfastly for a few minutes on a group of these insects, while feeding on the bark of the willow, a few of them will be perceived to elevate their bodies, and a transparent substance will evidently drop from them; which is immediately followed by a similar motion, and a discharge like a small shower, from a great number of others. On placing a piece of writing-paper under a mass of these insects, it soon became thickly spotted; holding it a longer time, the spots became united from the addition of others, and the whole surface assumed a glossy appearance. I tasted it, and found it as sweet as sugar. I had the less hesitation in doing this, having observed that wasps, flies, ants, and insects without number, devoured it as quickly as it was produced. In the height of summer, when the weather is hot and dry, and the aphides are most abundant, the foliage of the trees and plants upon which they reside is found covered by this substance, generally known by the name of *honey-dew*."

The astonishing fecundity of these insects has no parallel in the animal creation. In summer, the young are produced alive from the body of the parent; but in autumn, the female deposits *eggs* on the stems of plants, near the embryo shoots, and these are hatched by the sun early in the spring. How beautiful is this care of the Creator for the meanest of his creatures! If the autumnal brood of the aphides were brought forth as the summer one, the frosts of winter would inevitably kill all, and exterminate the race. The same sun which brings the eggs to maturity in spring, expands the young leaves upon which the parent insect intended her future progeny should feed: thus both leaves and insects come into life at the same time. But the most wonderful part of their history is the power of continued impregnation through a great many descents. A pregnant female, kept

by itself, produces perfectly formed young ones, which, though kept separate, will in a short time produce others; and thus several generations follow each other. The male insects only appear in autumn; and this may explain why the autumnal brood is enclosed in eggs. Réaumur computes that each aphis may produce about ninety young; and that, in consequence, in five generations the descendants from a single insect would amount to the astonishing number of 5,904,900,000! Were it not that these immense multitudes are called into being to furnish food for other races, they would be sufficient to destroy vegetation, and annihilate the empire of Flora. We accordingly find that, in "due season," they become the prey of many other animals, both in the bird and insect worlds. During most years, observes Mr. Curtis, the natural enemies of the aphides are sufficient to keep them in check, and to prevent them from doing essential injury to plants. But seasons sometimes occur when their increase is so prodigious that severe damage ensues, both to the crops of the husbandman and to vegetation generally. Among the hop plantations, for instance, the aphides are so prevalent, that the scarcity or abundance of the crop entirely depends upon their ordinary prevalence or unusual plenty; and hence the frequent reports on this subject in the newspapers. Vain would be the attempt to clear a hop garden of these pernicious insects, or to rescue any extensive crop from their baneful ravages.—SWAINSON: *Natural History and Arrangement of Insects.*

ANTS IN TROPICAL COUNTRIES.

As to Ants, I apprehend that, notwithstanding their number and familiarity, information is very imperfect relative to the varieties and habits of these marvellous insects in Ceylon. In point of multitude, it is scarcely an exaggeration to apply to them the figure of "the sands of the sea." They are everywhere—in the earth, in the houses, and in the trees; they are to be seen in every room and cupboard, and almost on every plant in the

jungle. To some of the latter they are, perhaps, attracted by the sweet juices secreted by the aphides and coccidæ; and such is the passion of the ants for sugar, and their wonderful facility of discovering it, that the smallest particle of a substance containing it, though placed in the least conspicuous position, is quickly covered with them, where not a single one may have been visible a moment before. But it is not sweet substances alone that they attack; no animal or vegetable matter comes amiss to them; no aperture appears too small to admit them. It is necessary to place everything which it may be desirable to keep free from their invasion under the closest cover, or on tables with a cup of water under each foot. As scavengers they are invaluable; and as ants never sleep, but work without cessation, during the night as well as by day, every particle of decaying vegetable or putrid animal matter is removed with inconceivable speed and accuracy. In collecting shells, I have been able to turn this propensity to good account: by placing them within their reach, the ants in a few days will remove every vestige of the mollusc from the innermost and otherwise inaccessible whorls; thus avoiding all risk of injuring the enamel by any mechanical process.

But the assaults of ants are not confined to dead animals alone—they attack equally such small insects as they can overcome, or find disabled from accidents or wounds; and it is not unusual to see some hundreds of them surrounding a maimed beetle, or a bruised cockroach, and hurrying it along to their nest in spite of every resistance. I have on more than one occasion seen a contest between them and one of the viscous ophidians (*Cæcilia glutinosa*), a reptile resembling an enormous earth-worm, common in the Kandyan hills, of an inch in diameter and nearly two feet in length. It would seem as if the whole community had been summoned and turned out for such a prodigious effort. They surrounded their victim literally in tens of thousands, inflicting wounds on all parts, and forcing it along towards their nest in spite of resistance. In one instance, to which I was a witness, the conflict lasted for the greater part of a day; but towards even-

ing the reptile was completely exhausted, and in the morning it had totally disappeared, having been carried away either whole or piecemeal by its assailants.

The species I here allude to is a very small ant, called the Koombyia in Ceylon. There is a still more minute form, which frequents the caraffes and toilet vessels, and is evidently a distinct species. A third, probably the *Formica nidificans* of Jerdan, is black, of the same size as that last mentioned, and from its colour called the *Kalu koombyia* by the natives. In the houses its propensities and habits are the same as the others; but I have observed that it frequents the trees more profusely, forming small paper cells for its young, like miniature wasps' nests, in which it deposits its eggs, suspending them from the leaf of a plant.

The most formidable of all is the great red ant or Dimiya (*Formica smaragdina*). It is particularly abundant in gardens and on fruit trees. It constructs its dwelling by gluing the leaves of such species as are suitable, from their shape and pliancy, into hollow bulbs, which it lines with a kind of transparent paper, like that manufactured by the wasp. I have watched them at the interesting operation of forming their dwellings. A line of ants standing on the edge of one leaf bring another into contact with it, and hold both together with their mandibles till their companions within attach them firmly by means of their adhesive paper, the assistants outside moving along as the work proceeds. If it be necessary to draw closer a leaf too distant to be laid hold of by the immediate workers, they form a chain by depending one from another till the object is reached, when it is at length brought into contact and made fast by cement. Like all their race, these ants are in perpetual motion, forming lines on the ground along which they pass, in incessant procession, to and from the trees on which they reside. They are the most irritable of the whole order in Ceylon, biting with such intense ferocity as to render it difficult for the unclad natives to collect the fruit from the mango trees, which the red ants especially frequent. They drop from the branches upon travellers in the

jungle, attacking them with venom and fury, and inflicting intolerable pain upon animals and man. On examining the structure of the head, I found that the mandibles, instead of merely meeting, are so hooked as to cross each other at the points, whilst the inner line is sharply serrated throughout its entire length; thus occasioning the intense pain of their bite, as compared with that of the ordinary ant.—TENNENT'S *Ceylon.*

THE FLYING-FISH.

In the tropical latitudes of the Atlantic, it was curious to watch the flight of the flying-fishes (*Exocetus volitans*), whole shoals of which rose quite close to the ship; and I have perfectly satisfied myself, not only on this occasion, but during the several times I have crossed the ocean, that they make use of their large pectoral fins as wings during the time they remain above the water. This fact I was particularly desirous to ascertain, as Cuvier, and all other authors I have consulted on the subject, except Humboldt, deny that this is the case. The distance they fly is sometimes very short; at others, I have watched them skimming along till the eye almost lost sight of them. I should say that they frequently extend their flight to three hundred yards. The height to which they rise above the surface of the sea does not usually exceed three or four feet, but that they rise higher is well known from the fact that they not unfrequently fly on board ships which are from ten to fifteen feet out of the water. When the sea is calm, they shoot along on the same plane like an arrow, and the impulse they acquire on leaving the water appears to be that alone which impels them onward. The first time I discovered that they certainly use their fins as wings, was one day when a rather high swell was running. A good many fishes were rising, but not in great numbers at the time. Solitary individuals could be followed by the eye to a great distance. During their progress they did not keep on the same plane, nor did the course of their flight form the segment of a circle, but they could

most distinctly be seen rising and falling over the heavy swell, keeping always at about the same height above the water; just as a bird would do when skimming along in search of food. The only time I ever distinctly saw the fins moved as wings was in the South Atlantic Ocean, one beautifully clear day, when we were running quietly along under the influence of a light breeze. Several dolphins were playing about, and one of them gave chase to a flying-fish, which rose, and in its flight was followed by the dolphin. It fell close to the ship, and in attempting to rise again the impulse was not sufficient to throw it completely out of the water. It flew along with its tail out of the sea for nearly a yard, when it fell a prey to its pursuer. Several of the other passengers were watching it also, and by all of us the large fins were seen to be worked with great rapidity. I agree with Humboldt that these fishes do not always rise out of the water to escape from their enemies, for they often spring up close to ships when there are no signs of large fish being near. Why should the flying-fish, having the power to do so, not enjoy a flight in the air quite as much as a duck does a dive under water, or land animals the luxury of bathing?—GARDNER: *Travels in Brazil.*

The following extract from his "Journey in Brazil" contains the opinion of Professor Agassiz, the most experienced, perhaps, of living naturalists:—"It requires but a superficial acquaintance with the anatomy of the flying-fishes to perceive that their organs of flight are built upon exactly the same pattern as the pectoral fins (the breast fins; Lat. *pectus*, the breast) of most fishes, and differ entirely from the wings of birds, as also from the wings of bats. No wonder, then, that the flight of the flying-fishes should entirely differ from that of birds or bats.

"I have had frequent occasions to observe the flying-fishes attentively. I am confident not only that they change the direction of their flight, but that they raise or lower their line of movement repeatedly, without returning to the water. I avoid the word *falling* designedly, for all the acts of these fishes during their flight seem to me to be completely voluntary. They raise themselves from the surface of the water by rapidly repeated

blows with the tail, and more than once I have seen them descend again to the surface of the water in order to repeat this movement; thus renewing the impulse and enabling themselves to continue for a longer time their passage through the air. Their changes of direction, either to the right or left, or in rising and descending, are not due to the beating of the wings, that is to say of the great pectoral fins, but simply to an inflexion of the whole surface, in one or the other direction, by the contraction of the muscles controlling the motion of the fin-rays—the pressure against the air determining the movement. The flying-fish is, in fact, a living shuttle-cock, capable of directing its own course by the bending of its large fins. It probably maintains itself in the air until the necessity of breathing compels it to return to the water. The motive of its flight seems to me to be fear; for it is always in the immediate neighbourhood and in front of the vessel they are seen to rise; or perhaps at a distance when they are pursued by some large fish.

"Now that I have studied their movements, I am better able to appreciate the peculiarities of their structure, especially the inequality of the caudal fin (tail-fin; Lat. *cauda*, a tail). It is perfectly clear that the greater length of the lower lobe of the caudal is intended to facilitate the movements by which the whole body is thrown out of the water and carried through the air; while the amplitude of the pectoral fins affords only a support during the passage through the lighter medium. Nothing shows more plainly the freedom of their movements than the fact that, when the surface of the sea is swelling into billows, the flying-fishes hug its inequalities very closely, and do not move in a regular course, first ascending from and then descending again to the level of the water. Nor do they appear to *fall* into their native element, as if the power that had impelled them had been exhausted; they seem rather to *dive* voluntarily into the water, sometimes after a short and sometimes after a rather protracted flight, during which they may change their direction as well as the height at which they move."

ELECTRIC FISHES.

There are some remarkable instances of the generation of electricity in living animals, to whom the power seems principally given as a means of defence. Of these animals, the *Raia torpedo* appears to have been noticed at a very early period, since descriptions of its properties are to be found in the writings of Greek and Roman naturalists. It inhabits the Mediterranean and North Seas, and full-grown specimens have been known to weigh from thirty to seventy pounds. Its electrical organs are situated in the anterior part of the body on both sides, and consist of perpendicular columns, arranged in honey-comb fashion, reaching from the upper to the under surface of the flattened body. Each column or cell is composed of a great number of partitions, and the number of the columns varies from a few hundred to upwards of a thousand, according to the size of the fish. The torpedo must be irritated to cause it to give a shock, in the delivery of which it moves its pectoral fins convulsively. The shock is felt on touching the fish with a single finger, and it can give a long series of shocks with great rapidity. When the torpedo is placed on a metallic plate, so that the plate touches the inferior surface of the organs, the hand that supports the plate never feels any shock, though another insulated person may excite the animal, and the convulsive movement of the pectoral fins may denote the strongest and most reiterated discharges. Direct contact with the electrical organs of the fish is indispensably necessary for the reception of the shock, but the torpedo has not the power of directing its electrical discharge through any particular object. By experiment it has been determined that the direction of the current is from the back to the belly; and that the discharge is capable of producing, like ordinary electricity, both thermal (Gr. *thermè*, heat) and chemical effects.

Another electric fish is the *Gymnotus electricus*, a native of the warmer regions of America and Africa. There are several species of gymnotus, but only one is electrical. In general

aspect it very much resembles an eel, the body being smooth and without scales—a peculiarity common to all electrical fishes. The electrical organs occupy more than a third of the length of the whole fish, and consist of two parts—viz., flat partitions stretching in the direction of the length, and of very thin membranes intersecting them transversely. Upwards of two hundred and forty of these membranes have been counted in a single inch. The organs are abundantly supplied by nerves, and though it is said they may be removed without injury to the fish, yet it is well known that their too frequent use is succeeded by debility and death. The electric shock of the gymnotus depends entirely on its will. It does not keep its organs always charged, and it can direct its action toward the point where it feels itself most strongly irritated. When two persons hold hands, and one touches the fish with his free hand, the shock is commonly felt by both at once. Occasionally, however, in the most severe shocks, the person who comes into immediate contact with the fish alone receives it. When a number of persons dip their hands at the same time into the water in the vessel in which the gymnotus is confined, they *all* receive a shock of greater or less intensity when the fish discharges, proving that all the conducting matter around the animal is filled at the moment with circulating electric power resembling generally in disposition the magnetic curves of a magnet. The gymnotus feeds on other fishes, which it kills by giving them a shock: this it does by forming a coil around its victim, so that it should represent a diameter across it. Living, as the gymnotus does, in the midst of such a good conductor as water, it seems at first sight surprising that it can sensibly electrify anything; but, in fact, it is the very conducting power of the water which favours and increases the shock, by moistening the skin of the animal through which the gymnotus discharges its battery.

A third electric fish is the *Silurus electricus*, found in the Senegal, Niger, Nile, and other large rivers of Northern Africa. When full-grown it is from twenty to thirty inches long. The shock is distinctly felt when it is laid on one hand, and touched

by a metallic rod held in the other. Its electric organs are much less complicated than those of other electric fishes. Besides the preceding, there are other fishes possessing the property of giving shocks, such as the *Tetraodon electricus*, found near the Canary Islands; the *Trichiarus electricus*, inhabiting the Indian seas; and several others whose organs and habits have not yet been accurately described.—*Adapted from* NOAD's *Text-Book of Electricity*.

BURYING FISHES.

A STILL more remarkable power possessed by some of the Ceylon fishes, is that of secreting themselves in the earth in the dry season, at the bottom of the exhausted ponds, and there awaiting the renewal of the water at the change of the monsoon. The instinct of the crocodile to resort to the same expedient is well known; and in like manner the fishes, when distressed by the evaporation of the tanks, seek relief by immersing first their heads and by degrees their whole bodies in the mud, and sinking to a depth at which they find moisture sufficient to preserve life in a state of lethargy long after the bed of the tank has been consolidated by the intense heat of the sun. It is possible, too, that the cracks which reticulate the surface may admit air to some extent to sustain their faint respirations.

The same thing takes place in other tropical regions, subject to the vicissitudes of drought and moisture. The Protopterus which inhabits the Gambia is accustomed in the dry season, when the river retires into its channel, to bury itself to the depth of twelve or sixteen inches in the indurated mud of the banks, and to remain in a state of torpor till the rising of the stream after the rains enables it to resume its active habits. At this period the natives of the Gambia, like those of Ceylon, resort to the river and secure the fishes in considerable numbers as they flounder in the still shallow water. A parallel instance occurs in Abyssinia in relation to the fishes of the Mareb, one of the sources of the Nile, the waters of which are partially absorbed in traversing

the plains of Taka. During the summer its bed is dry, and in the slime at the depth of more than six feet is found a species of fish without scales, different from any known to inhabit the Nile.

In South America, the "round-headed hassar" of Guiana (*Callichthys littoralis*), and the "yarrow," a species of the pike family, although they possess no specially modified respiratory organs, are accustomed to bury themselves in the mud on the subsidence of water in the pools during the dry season. The *Loricaria* of Surinam, another siluridan, exhibits a similar instinct, and resorts to the same expedient. Sir R. Schomburgh, in his account of the fishes of Guiana, confirms this account of the callichthys, and says, "They can exist in muddy lakes without any water whatever, and great numbers of them are sometimes dug up from such situations."

In those portions of Ceylon where the country is flat, and small tanks are extremely numerous, the natives in the hot season are accustomed to dig in the mud for fish. Mr. Whiting, the chief civil officer of the eastern province, informs me that on two occasions he was present accidentally when the villagers were so engaged; once at the tank of Malliativoe, within a few miles of Kothar, near the bay of Trincomalie; and again at a tank between Ellendetorre and Arnetivo, on the banks of the Virgel river. The clay was firm, but moist, and as the men flung out lumps of it with a spade, it fell to pieces, disclosing fishes from nine to twelve inches long, which were full-grown and healthy, and jumped on the bank when exposed to sun-light. Being desirous of obtaining a specimen of the fish so exhumed, I received from the Moodliar of Matura one taken along with others of the same kind from a tank in which the water had dried up. It was found at the depth of a foot and a half, where the mud was still moist, whilst the surface was dry and hard. The fish which the Moodliar sent to me proved to be an anabas, and closely resembled the climbing perch (*Perca scandens*) of Daldorf.

Dr. John Hunter has ventured the opinion that hibernation,

although a result of cold, is not its immediate consequence, but is attributable to that deprivation of food and other essentials which extreme cold occasions, and against the recurrence of which nature makes a timely provision, by a suspension of two functions. Excessive heat in the tropics produces an effect upon animals and vegetables analogous to that of excessive cold in northern regions; and hence it is reasonable to suppose that the torpor induced by the one may be but the counterpart of the hibernation which results from the other. The frost which imprisons the alligator in the Mississippi as effectually cuts him off from food and action, as the drought which incarcerates the crocodile in the sun-burned clay of a Ceylon tank. The hedge-hog of Europe enters on a period of absolute torpidity as soon as the inclemency of winter deprives it of its ordinary supply of slugs and insects; and the tenrec of Madagascar, its tropical representative, exhibits the same tendency during the period when excessive heat produces in that climate a like result. On the other hand, ants, which are torpid in Europe during winter, work all the year round in India, where sustenance is uniform. A similar observation applies to the bats, which are dormant during a northern winter when insects are rare, but never become torpid in any part of the tropics.

To the fishes in the detached tanks and pools, when the heat, by exhausting the water, deprives them at once of motion and sustenance, the practical effect must be the same as when the frost of a northern winter encases them in ice. Nor is it difficult to believe that they can successfully undergo the one crisis when we know beyond question that they may survive the other.—*Abridged from* TENNENT'S *Ceylon.*

THE EIDER-DUCK AND ITS DOWN.

THIS celebrated member of the Duck family in size approaches nearer to the goose than to the duck, being above two feet long, and weighing about seven pounds. Its native country extends

from about 45° north to the highest arctic latitude hitherto explored both in Europe and in America—the Farne Islands off the coast of Northumberland, and the rocky islets beyond Portland, in the district of Maine, being the southern boundary of their breeding places. They are only very plentiful, however, in Behring Strait, Labrador, Greenland, Iceland, and other arctic regions.

According to M. T. Brunnich, who wrote a special treatise on the natural history of the eider-duck (*Somateria mollissima*), their first object after pairing is to procure a suitable place for their nest, preferring the shelter of a juniper bush where it can be had, and where there is no juniper contenting themselves with tufts of sea-grass, bundles of sea-weed cast up by the tide, the crevices of rocks, or any hollow place which they can find. Some of the Icelandic proprietors of breeding-grounds, in order to accommodate them, cut out holes on the smooth sloping banks, where they would not otherwise build, but of which they gladly take possession when thus scooped out. It is not a little remarkable that, like several other sea-birds, they almost always select small islands; their nests being seldom if ever found on the shores of the mainland, or even of a large island. The Icelanders are so well aware of this, that they have expended a great deal of labour in actually forming islands, by separating from the mainland certain promontories which had narrow isthmuses. The reason of this preference for islands seems to be security from the intrusion of dogs, cattle, and other land animals, to whose vicinity they have so great an aversion that the Icelanders are careful to remove these, as well as cats, to a distance from their settlements.

Both the male and female work in concert in building their nest, laying a rather coarse foundation of drift grass, dry tangle, and sea weed, which is collected in some quantity. Upon this rough mattress the female eider spreads a bed of the finest down plucked from her own breast, and by no means sparingly, but, as Brunnich informs us, heaping it up, so as to form a thick puffed roll quite round the nest. When she is compelled to go in search of food, after beginning to sit, she carefully turns the

marginal roll of down over the eggs to keep them warm till her return. Martens says she mixes the down with moss; but as this is not recorded by any other observer, we think it is not a little doubtful, particularly as in the places chosen for nestling she would find it no easy matter to procure moss. It is worthy of remark, that though the eider lays only five or six eggs, it is not uncommon to find even ten and upwards in the same nest, occupied by two females which live together in perfect concord.

The quantity of down in each nest is said by Von Troil to be about half a pound, which by cleaning is reduced one half. By Pennant, who examined the eiders' nests on the Farne islands, off Northumberland, it was only estimated, when cleaned, at three-quarters of an ounce, and this was so elastic as to fill the crown of the largest hat. The difference in quantity in these two accounts, theoretically ascribed to difference of climate, may have arisen from the one being the first, and the other the second or third nest of the mother duck; for if the first nest be plundered of its down, though she immediately builds a second, she cannot furnish it with the same quantity as before; and if forced to build a third time, having then stripped her breast of all she could spare, the male is said to furnish what is wanting, which is recognized as being considerably whiter than the female's. When the nest is not robbed, it is said that he furnishes none. The extraordinary elasticity of the down appears from the fact we have mentioned, of three-quarters of an ounce filling a large hat. It is worthy of notice, however, that it is only the down taken from the nests which has this great elasticity, for what is taken from the dead birds is much inferior. The cause of this difference has been attributed either to the down being in perfection at the breeding season, or to the bird plucking only her finest and most delicate feathers.

The down taken from the nests becomes a valuable article of commerce, being sold, when cleaned, at prices from twelve shillings and upwards a pound. Little or none of it is used in the countries where it is found. In that rough climate, as Buffon remarks, the hardy hunter, clothed in a bear-skin cloak,

enjoys in his solitary hut a peaceful, perhaps a profound sleep; while in polished nations, the man of ambition, stretched upon a bed of eider-down and under a gilded roof, seeks in vain to procure the sweets of repose.—*Abridged from* RENNIE'S *Architecture of Birds.*

THE SWALLOW FAMILY.

THE *Hirundinidæ*, or swallow family, which visit this country, are, the chimney-swallow (*Hirundo rustica*), the martin (*H. urbica*), the sand-martin (*H. riparia*), the common swift (*H. apus*), and—but very rarely—the alpine or white-bellied swift (*H. Alpinus*).*

The chimney-swallow makes his appearance amongst us earlier or later, according to the mildness or severity of the season, but the 10th of April appears to be the general average of his arrival. The earliest period noted by White in his "Natural History of Selborne" is the 26th of March, and the latest the 20th of April. It would be a waste of time to do more than hint at the exploded fables of swallows retiring under water in the winter; for the evidence of the migration of the whole family is now so complete that it amounts to absolute proof. Again and again have they been seen crossing the sea, sometimes dipping into it to take a marine bath, and then pursuing their journey refreshed and exhilarated. "The house or chimney-swallow," says Sir Humphry Davy, "lives a life of continual enjoyment among the loveliest forms of nature; winter is unknown to him, and he leaves the green meadows of England in autumn for the myrtle and orange groves of Italy and for the palms of Africa." To us, indeed, he is the harbinger of spring, and his advent has been welcomed, and will be welcomed so long as the seasons endure. Besides his welcome advent, he gladdens the air with his swift and elegant movements as well as with his low and delicate warble; for in soft and sunny weather he sings both perching

* The swifts constitute the genus *Cypselus* of modern authors; hence in many works *C. apus* and *C. Alpinus*, &c.

and flying—on chimney-tops and house-ridges, in a kind of concert.

The martin, with his pure white lower back and under parts, most probably turns his flight northward from Africa at the same time with the house-swallow; but his powers of wing cannot keep pace with the extensive sail of the latter, and he generally arrives a few days later. The earliest and latest periods recorded by White are the 28th of March and the 1st of May. The sand-martin arrives earlier than either of the other two species. The earliest and latest dates noted by White are the 21st of March and the 12th of April. The average time of the arrival of the common swift is early in May, but White saw it as early as the 13th of April; and the latest time noted by him is the 7th of May. The great alpine swift, which chooses the highest rocks and the most towering cathedrals for his resting-places, can only be considered as an accidental visitor to these islands, and does not appear to have been seen here earlier than June.

The architecture of the first three species above noticed deserves attention. Early in the season the swallows and house-martins may be seen on the ground in moist places, or near the edges of ponds and puddles. They are then collecting the clay or mortar, which, strengthened with straws and grass stems to keep it together in the case of the swallow, is to form their nest. One course is laid on at a time, and that is left to settle and dry before the next is added; and thus the work proceeds day after day, till the saucer-shaped nest of the swallow and the hemispherical cob-house * of the martin are completed. The sand-martin proceeds upon a different plan: he is a miner, and excavates his dwelling in the sand-bank, as the ancient Egyptian carved his temple out of the solid rock. Look at the bill of this little bird. Though small, it is hard and sharp, and well our sapper knows how to use it. Clinging to the face of the sand-bank with his sharp little claws, and closing his bill, the bird works away with his natural pick-axe, till the hard sand comes

* *Cob*, a Devonshire term for an admixture of clay and straw employed in the building of garden walls, out-houses, cottages, and even houses of higher pretensions.

tumbling down on all sides. Round he goes, now with his head up, now down, till he has planned his circular cave as regularly almost as compasses could do it; and yet he does not trace it out from a fixed point in the centre, but works from the circumference. When he has well broken ground, he tunnels away as truly as Sir Isambard Brunel himself (the engineer of the Thames Tunnel); and while the bird works into his excavation, he shifts his position as the necessities of the case require; now standing on the floor, now clinging to the roof with his back downwards; and how carefully does he remove the rubbish from the upward inclined floor with his feet (all four of his toes are directed forward), taking care not to disturb the solidity!

The nest of the common swift is a farrago of bits of rag, a feather or two, dry grass blades and stems, and fragments of straw; but these materials appear to be cemented or glued together. What this glue is composed of is not known, though some have supposed it to be the saliva, or a mucous secretion of the bird itself. The nests of the Chinese swallow, with which the brother of the sun and moon enriches his soup when they are clean and fair, and glues his bamboo-seat when they are dark and dirty, are said to owe their glutinous quality to *ulvæ*, or seaweeds, like our laver, worked up by the builders. But the nest of the common swift, which is deposited under the eaves of the old house or church, in a hole in a steeple, or in some antiquated turret, has generally a very compressed appearance, the result of pressure of generation after generation there hatched and reared.

As summer declines and the latest broods are fledged, the various species assemble in flocks, some earlier and some later, but generally in September and October, and wing their flights to the warmer latitudes of southern Spain and the northern coasts of Africa. There they escape the rigours of our winter, and await the return of another spring.

The purple martin of the United States (*H. purpurea*) appears to be as great a favourite with our transatlantic brethren as the swallows and martins are with us.—BRODERIP'S *Zoological Recreations and* WHITE'S *Selborne.*

THE GLOSSY CROW OF CEYLON.

OF all the Ceylon birds the most familiar and notorious is the small glossy Crow, whose shining black plumage shot with blue has obtained for him the title of *Corvus splendens*. These birds frequent the towns in companies, and domesticate themselves in the close vicinity of every house; and it may possibly serve to account for the familiarity and audacity which they exhibit in their intercourse with men, that the Dutch, during their sovereignty in Ceylon, enforced severe penalties against any one killing a crow, under the belief that the bird was instrumental in extending the growth of cinnamon by feeding on the fruit, and thus disseminating the undigested seed.

So accustomed are the natives to its presence and exploits, that, like the Greeks and Romans, they have made the movements of the crow the basis of their auguries; and there is no end to the vicissitudes of good and evil fortune which may be predicted from the direction of their flight, the hoarse or mellow notes of their croaking, the variety of trees on which they rest, and the numbers in which they are seen to assemble. All day long they are engaged in watching either the offal of the offices or the preparation for meals in the dining-room; and as doors and windows are necessarily opened to relieve the heat, nothing is more common than the passage of crows across the room, lifting while on the wing some ill-guarded morsel from the dinner-table. No article, however unpromising its quality, provided only it be portable, can with safety be left unguarded in any apartment accessible to them. The contents of ladies' work-boxes, kid-gloves, and pocket-handkerchiefs vanish instantly, if exposed near a window or open door. They open paper parcels to ascertain the contents; they will undo the knot on a napkin if it encloses anything eatable; and I have known a crow to extract the peg which fastened the lid of a basket, in order to plunder the provender within.

One of these ingenious marauders, after vainly attitudinizing

in front of a chained watch-dog which was lazily gnawing a bone, and after fruitlessly endeavouring to divert his attention by dancing before him with head awry and eye askance, at length flew away for a moment, and returned bringing with it a companion, which perched itself on a branch a few yards in the rear. The crow's grimaces were now actively renewed, but with no better result, till its confederate, poising itself on its wings, descended with the utmost velocity, striking the dog upon the spine with all the force of its beak. The *ruse* was successful; the dog started with surprise and pain, but not quickly enough to seize his assailant, whilst the bone he had been gnawing disappeared the instant his head was turned! Two well-authenticated instances of the recurrence of this device came within my knowledge at Colombo, and attest the sagacity and powers of communicating and combining possessed by these astute and courageous birds.

On the approach of evening the crows assemble in noisy groups along the margin of the fresh-water lake which bounds Colombo on the eastern side. Here for an hour or two they enjoy the luxury of the bath, tossing the water over their shining backs, and arranging their plumage decorously; after which they disperse, each taking the direction of its accustomed quarters for the night. In Bellingam Bay, a little to the east of Point-de-Galle, a small island, covered with cocoa-nut trees, has acquired the name of "Crow Island" from being the resort of those birds, which are seen hastening towards it in thousands towards sunset.—TENNENT'S *Ceylon*.

THE BURROWING OWL OF AMERICA.

AMONG mining birds—that is, those which excavate holes for their nests or for the purposes of permanent shelter—the Burrowing Owl of America (*Strix cunicularia*) is one of the most marked and peculiar. "In the trans-Mississippian territories of the United States," says Charles L. Buonaparte, "he resides exclu-

sively in the villages of the marmot or prairie dog, whose excavations are so commodious as to render it unnecessary that our bird should dig for himself, as he is said to do in other parts of the world, where no burrowing animals exist. These villages are very numerous and variable in their extent, sometimes covering only a few acres, and at others spreading over the surface of the country for miles together. They are composed of slightly elevated mounds, having the form of a truncated cone, about two feet in width at base, and seldom rising as high as eighteen inches above the surface of the soil. The entrance is placed either at the top or on the side, and the whole mound is beaten down externally, especially at the summit, resembling a much used footpath.

"From the entrance the passage into the mound descends vertically for one or two feet, and is thence continued obliquely downwards until it terminates in an apartment, within which the industrious marmot constructs, on the approach of the cold season, the comfortable cell for his winter sleep. This cell, which is composed of fine dry grass, is globular in form, with an opening at top capable of admitting the finger; and the whole is so firmly compacted that it might without injury be rolled over the floor. It is delightful, during the fine weather, to see these lively little creatures sporting about the entrance to their burrows, which are always kept in the neatest repair, and are often inhabited by several individuals. When alarmed, they instantly take refuge in their subterranean chambers; or, if the dreaded danger be not immediately impending, they stand near the brink of the entrance, bravely barking and flourishing their tails, or else sit erect to reconnoitre the movements of the enemy. The mounds thrown up by the marmot in the neighbourhood of the Rocky Mountains have an appearance of greater antiquity than those observed on the far-distant plains. They sometimes extend to several yards in diameter, although their elevation is trifling; and, except immediately around the entrance, are clothed with a scanty herbage, which always distinguishes the area of these villages. Sometimes several villages have been observed almost

entirely destitute of vegetation; and recollecting that the marmot feeds exclusively on grasses and herbaceous plants, it seems singular that this animal should always choose the most barren spot for the place of his abode. However this may be accounted for, it at least affords an opportunity of beholding the approach of his enemies, and allows him to seek, within the bosom of the earth, that security which he has neither strength nor arms to command.

"In all these prairie-dog villages the burrowing owls are seen moving briskly about, or else in small flocks, scattered among the mounds, and at a distance may be mistaken for the marmot himself when sitting erect. They manifest but little timidity, and allow themselves to be approached sufficiently near for shooting; but if alarmed, some or all of them soar away, and settle down at a short distance. If further disturbed, their flight is continued until they are no longer in view, or they descend into their dwellings, from which they are difficult to dislodge. The burrows into which these owls have been seen to descend, on the plains of the river Plortte, where they are most numerous, had evidently been excavated by the marmots; whence it has been inferred that they were either common, though unfriendly, residents of the same habitation, or that our owl was the sole occupant of a burrow acquired by right of conquest. The evidence of this latter inference was clearly presented by the ruinous condition of the burrows tenanted by the owl, which were frequently caved in and their sides channelled by the rains, while the neat and well-preserved mansion of the marmot showed the active care of a skilful and industrious owner.

"We have no evidence that the owl and marmot habitually resort to one burrow; yet we are well assured, by competent observers, that a common danger often drives them into the same excavations, where lizards and rattlesnakes also enter for concealment and safety. Throughout the region traversed by the expedition, the marmot was unquestionably the artificer of the burrow inhabited by the owl."—*American Ornithology.*

THE CONDOR OF THE ANDES.

In those sterile heights Nature withholds her fostering influence alike from vegetable and animal life. The scantiest vegetation can scarcely draw nutriment from the ungenial soil, and animals shun the dreary and shelterless wilds. The condor, or South American vulture, alone finds itself in its native element amidst these mountain deserts. On the inaccessible summits of the Cordillera, and at an elevation of from 10,000 to 15,000 feet, this bird builds its nest, and hatches its young in the months of April and May. Few animals have attained so universal a celebrity as the condor. This bird was known in Europe at a period when its native land was numbered among those fabulous regions which are regarded as the scenes of imaginary wonders. The most extravagant accounts of the condor were written and read, and general credence was granted to every story which travellers brought from the fairy land of gold and silver. It was only at the commencement of the present century that Humboldt overthrew the extravagant notions that previously prevailed respecting the size, strength, and habits of this extraordinary bird.

The full-grown condor measures, from the point of the beak to the end of the tail, from four feet ten inches to five feet; and from the tip of one wing to that of the other, from twelve to fourteen feet. This bird feeds chiefly on carrion; it is only when impelled by hunger that it seizes living animals, and even then only the small and defenceless, such as the young of sheep, vicuñas, and llamas. It cannot raise great weights with its feet; which, however, it uses to aid the power of its beak. The principal strength of the condor lies in its neck and in its feet; yet it cannot, when flying, carry a weight exceeding eight or ten pounds. All accounts of sheep and calves being carried off by condors are mere exaggerations. The bird passes a great part of the day in sleep, and hovers in quest of prey chiefly in the morning and evening. Whilst soaring at a height beyond the reach of human eyes, the sharp-sighted condor discerns its prey on the level

heights beneath it, and darts down upon it with the swiftness of lightning. When a bait is laid, it is curious to observe the number of condors which assemble in a quarter of an hour in a spot near which not one had been previously visible. These birds possess the senses of sight and smell in a singularly powerful degree.

Some old travellers—Ulloa, among others—have affirmed that the plumage of the condor is invulnerable to a musket-ball. This absurdity is scarcely worthy of contradiction; but it is nevertheless true that the bird has a singular tenacity of life, and that it is seldom killed by fire-arms, unless when shot in some vital part. Its plumage, particularly on the wings, is very strong and thick. The natives, therefore, seldom attempt to shoot the condor; they usually catch it by traps or by the lasso, or kill it by stones flung from slings, or by the *bolas*—balls of stone or iron attached to a thong and thrown with great force and precision. A curious method of capturing the condor alive is practised in the province of Abancay. A fresh cow-hide, with some fragments of flesh adhering to it, is spread out on one of the level heights, and an Indian provided with ropes creeps beneath it, whilst some others station themselves in ambush near the spot ready to assist him. Presently a condor, attracted by the smell of the flesh, darts down upon the cow-hide, and then the Indian, who is concealed under it, seizes the bird by the legs, and binds them fast in the skin, as if in a bag. The captured condor flaps its wings, and makes ineffectual attempts to fly, but is speedily secured, and carried in triumph to the nearest village. Live condors are frequently sold in the markets of Chili and Peru, and a very fine one may be purchased for a dollar and a half.—Dr. J. Von Tschudi: *Travels in Peru.*

FUR-BEARING ANIMALS OF NORTH AMERICA.

The animals which furnish the valuable furs from the northern regions of America are the silver and cross foxes, the fisher, mar-

ten, otter, mink, and lynx; whilst among those of less worth are the wolverine, beaver, ermine, and musk-rat. The beaver was formerly found in great numbers, and was pretty highly prized; but from the assiduity with which it has been hunted, it has now become comparatively scarce; and from the substitution of silk for beaver-skin in the manufacture of hats, the latter has become almost worthless. Of all furs, with the single exception of the sea-otter, which is found only on the Pacific coast, the silver fox commands the highest price. The fur of the silver fox is of a beautiful gray; the white hairs, which predominate, being tipped with black, and mixed with others of pure black. A well-matched pair of silver-fox skins are worth from £80 to £100. The cross foxes, so called from the dark stripe down the back, with a cross over the shoulders like that on a donkey, vary in every degree between the silver and the common red fox, and the value of their skins varies in the same ratio. After the best cross foxes come the fisher, the marten, and the mink. These three are all animals of the pole-cat tribe, and both in size and value may be classed in the order in which they have been mentioned. The skin of a fisher fetches from sixteen to thirty shillings; of a marten, from fifteen to twenty-three shillings; and of a mink, from ten to fifteen shillings. The otter, which is less common than the two last named, commands a price of one shilling an inch, measured from the head to the tip of the tail. The ermine is exceedingly common in the forests of the North-West, and is a nuisance to the trapper, destroying the baits set for the marten and the fisher. It is generally considered of too little value to be the object of the trapper's pursuit. The black bear is also occasionally discovered in his winter hole, and his skin is worth about forty shillings. The lynx is by no means uncommon, and generally taken by snares of hide. When caught he remains passive and helpless, and is easily despatched by the hunter. The other denizens of the forest are the moose and smaller game, such as the common wood partridge or willow grouse, the pine partridge, the rabbit, and the squirrel. By far the most numerous of the more valuable fur animals in this region are the marten and the mink, and to the

capture of the former of these two—the *sable* of English furriers—the exertions of the trapper are principally directed.

At the beginning of November, when the animals have got their winter coats, and fur is "in season," the trapper prepares his pack, which he makes in the following manner: Folding his blanket double, he places in it a lump of pemmican sufficient for five or six days' consumption, a tin kettle and cup, and, if he is rich, some steel traps, and a little tea and salt. The blanket is then tied at the four corners, and slung on the back by a band across the chest. A gun and ammunition, axe, knife, and fire-bag, complete his equipment. Tying on a pair of snow-shoes, he starts alone into the gloomy woods. Trudging silently forward—for the hunter or trapper can never lighten the solitude of his journey by whistling or a song—his keen eye scans every mark upon the snow for the tracks he seeks. When he observes the footprints of marten or fisher he unslings his pack, and sets to work to construct his traps. There is something strangely attractive in the life, in spite of the hardships and fatigue which attend it. The long, laborious march, loaded with a heavy pack, and cumbered with a quantity of thick clothing, through snow and woods beset with fallen timber and brushwood, is fatiguing enough. The only change is the work of making the traps, or the rest at night in camp. Provisions usually fall short, and the trapper subsists in great measure upon the flesh of the animals captured to obtain the fur. But, on the other hand, the grand beauty of the forest, whose pines, some of which tower up above two hundred feet in height, are decked and wreathed with snow, and where no sound is heard except the occasional chirrup of a squirrel, or the explosions of trees cracking with intense frost, excites admiration and stimulates curiosity. The intense stillness and solitude, the travelling day after day through endless woods without meeting a sign of man, and rarely *seeing* a living creature, strikes very strangely on the mind at first. The half-breed trapper delights in wandering alone in the forest. The interest in the pursuit is constantly kept up by the observation of tracks, and by visiting the traps previously made; and at night, lying on a soft, elastic

couch of pine boughs, at his feet a roaring fire of great trees heaped high, from which rises an enormous column of smoke and steam from the melted snow, the trapper, rolled up in his blanket, sleeps in peace.—*Abridged from* MILTON *and* CHEADLE'S *North-West Passage by Land.*

THE ELEPHANT—INDIAN AND AFRICAN.

ALTHOUGH the elephant is found throughout many countries, extending over an enormous area, there are only two species at present in existence—the Indian and the African. These are totally different in their habits, and are distinguished by peculiarities of form. The most striking difference is in the shape of the head and spine. The head of the Indian species is perfectly distinct. The forehead, when held in the natural position of inaction, is perpendicular, and above the slight convexity at the root of the trunk there is a depression in shape like a herald's shield. A bullet in the lower portion of that shield will reach the brain in a direct line. The head of the African elephant is completely convex from the commencement of the trunk to the back of the skull, and the brain is situated much lower than in that of the Indian species. The bone is of a denser quality, and the cases for the reception of the tusks are so closely parallel that there is barely room for a bullet to find a chance of penetrating to the brain: it must be delivered in the exact centre, and extremely low, and in the very root of the trunk; even then it will frequently pass above the brain, as the animal generally carries his head high, and thrown slightly back. The teeth of the African elephant differ materially from those of the Indian, by containing fewer laminæ or plates; the surfaces of which, instead of exhibiting straight and parallel lines like those of the Indian, are shaped in slight curves, which increase the power of grinding. The ears of the African species are enormous, and when thrown back they completely cover the shoulders; they are also entirely different in shape from those of the Indian species. When an African bull elephant advances in full charge with his ears cocked,

his head measures about fourteen feet from the tip of one ear to that of the other, in a direct line across the forehead! I have frequently cut off an ear to form a mat, upon which I have slept beneath the shade of a tree, while my people divided the animal. The back of the Indian elephant is exceedingly convex; that of the African is exactly the reverse, and the concavity behind the shoulders is succeeded by a peculiarity in the sudden rise in the spine above the hips.

The two species are not only distinct in certain peculiarities of form, but they differ in their habits. The Indian elephant dislikes the sun, and invariably retreats to thick shady forests at sunrise; but I have constantly found the African species enjoying themselves in the burning sun in the hottest hours of the day, among plains of withered grass many miles from a jungle. The African is more active than the Indian, and not only is faster in his movements, but is more capable of enduring long marches, as proved by the great distances through which he travels to seek his food in the corn-fields of the natives. In all countries the bulls are fiercer than the females. I cannot see much difference in character between the Indian and the African species. It is the fashion for some people to assert that the elephant is an innocent and harmless creature—which, like the giraffe, it is almost a sin to destroy. I can only say, that during eight years' experience in Ceylon, and nearly five years' in Africa, I have found that elephants are the most formidable animals with which a sportsman has to contend. The African species is far more dangerous than the Indian, as the forehead shot can never be trusted; therefore the hunter must await the charge with a conviction that his bullet will fail to kill.

The African elephant is about a foot higher than the average of the Indian species. The bulls of the former are about ten feet six inches at the shoulder; the females are between nine feet and nine feet six. Of course there are many bulls that exceed this height, and I have seen some few of both species that might equal twelve feet, but those are the exceptional Goliaths.

The tusks of elephants vary considerably, and there appears to

be no rule whereby to determine their size and quality. In Abyssinia and Taka a single tusk of a bull elephant seldom exceeds forty pounds, nor do they average more than twenty-five; but in Central Africa they average about forty, and I have seen them upwards of one hundred and fifty pounds. The largest that I have had the good fortune to bag was eighty pounds; the fellow tusk was slightly below seventy. Elephants invariably use one tusk in preference, as we use the right hand; thus it is difficult to obtain an exact pair, as the hadām (or servant), as the Arabs call the working tusk, is generally much worn.

The African elephant is a more decided tree-feeder than the Indian, and the destruction committed by a large herd of such animals, when feeding in a mimosa forest, is extraordinary. They deliberately march forward and uproot or break down every tree that excites their appetite. The mimosas are generally from sixteen to twenty feet high, and, having no tap-root, they are easily overturned by the tusks of the elephants, which are driven like crowbars beneath the roots, and used like levers; in which rough labour they are frequently broken. Upon the overthrow of a tree, the elephants eat the roots and leaves, and strip the bark from the branches by grasping them with their rough trunks.

The African elephant is equally docile with the Indian, when domesticated; but we have no account of a negro tribe that has ever tamed one of these sagacious animals: their only maxim is, "Kill and eat."—Baker's *Nile Tributaries of Abyssinia.*

VAMPIRE BATS OF BRAZIL.

For several nights before we reached Riachâo the horses were greatly annoyed by bats, which are very numerous on this sierra, where they inhabit the crevices in the limestone rocks; and during the night we remained there, the whole of my troop suffered more than they had on any previous occasion. All exhibited one or more streams of clotted blood on their shoulders and backs, which had run from the wounds made by these

animals, and from which they had sucked their fill of blood. When a small sore exists on the back of a horse, they always prefer making their incision on that place. The owner of the house where we stopped informed me that he was not able to rear cattle, on account of the destruction made by the bats among the calves, so that he was obliged to keep them at a considerable distance, in a lower part of the country. Even the pigs did not escape their attacks.

These singular creatures, which are productive of so much annoyance, constitute the genus *Phyllostoma:* so named from the leaf-like appendage attached to their upper lip (Gr. *phyllon*, a leaf; and *stoma*, the mouth). They are peculiar to the continent of America, being distributed over the immense extent of territory between Paraguay and the Isthmus of Darien. Their tongue, which is capable of considerable extension, is furnished at its extremity with a number of papillæ, which appear to be so arranged as to form an organ of suction; and their lips also have tubercles symmetrically arranged: these are the organs by which they draw the life-blood of both man and beast. These animals are the famous "vampires" of which various travellers have given such redoubtable accounts, and which are known to have nearly destroyed the first establishment of Europeans in the New World. The molar teeth of the true vampire, or spectre-bat, are of the most carnivorous character; the first being short, and almost plain, the others sharp and cutting, and terminating in three and four points. Their rough tongue has been supposed to be the instrument employed in abrading the skin, so as to enable them more readily to abstract the blood; but zoologists are now agreed that such supposition is wholly groundless. Having carefully examined, in many cases, the wounds made on horses, mules, pigs, and other animals (observations that have been confirmed by information received from the inhabitants of the northern parts of Brazil), I am led to believe that the puncture which the vampire makes in the skin of animals is effected by the sharp hooked nail of its thumb, and that from the wound thus made it abstracts the blood by the suctorial powers of its lips and tongue.

That these bats attack man, as well as other animals, is certain, for I have frequently been shown the scars of their punctures on the toes of many who had suffered from their attacks; but I never met with a recent case. They grow to a large size, and I have killed some that measured two feet between the tips of the wings. —GARDNER: *Travels in the Interior of Brazil.*

SAGACITY OF MONKEYS.

THE moist and marshy Campos produce various kinds of palm trees, which bear large clusters of small nuts, greatly resembling miniature cocoa-nuts. When ripe, these are covered externally with a fibrous, oily substance, which has a sweetish taste, and constitutes the favourite food of little ring-tailed monkeys (*Ateles paniscus*), which are no less fond of the internal part of the nut, which contains a similar substance to that found in cocoa-nuts. In several parts of the interior I had been told that to get at the kernal, the shell being too hard to break with their teeth, the monkeys carry the nuts to a rocky place, and then break them with a stone; and I even met with persons who assured me that they had watched them in such places through the bushes, and actually seen them engaged in this operation. This account I always considered to be fabulous till I arrived at Sapê. In an excursion we made over the Sierra, where it is composed of nearly bare, rugged limestone peaks, in several almost inaccessible places we came upon large heaps of the broken shells of nuts, generally on a bare open part of the rock; and along with them a number of roundish pieces of stone, larger than the fist, which had evidently been employed in breaking the shells. These, Senhor Lagoeira told me, were the places resorted to by the monkeys for the purpose of breaking the nuts collected in the low grounds; and he said that in his shooting excursions over the mountains he had frequently seen them take flight on his approach. That they both can and really do make use of a stone in order to break that which is too hard for their teeth, I have frequently witnessed in a

little pet monkey that accompanied me on my journey. I obtained it at Piauhy, and it was the only one of the many tame animals I carried with me that reached Rio de Janeiro alive. It was a female of the species we are now speaking of, and ultimately became very gentle. Jerry was the favourite with all, and, indeed, in all respects fared like ourselves. It became so fond of tea, which it drank every morning and evening, that it would not go to sleep without its regular allowance. Its favourite food was farinha, boiled rice, and bananas; but scarcely anything came amiss to it. A raw egg was a choice morsel, and on being given to it, it broke one end by gently knocking it on the floor, and completed the hole by picking off the broken bits of shell and putting in the point of its long slender finger; throwing back its head, and holding the egg erect between its two hands, it soon contrived to suck out the whole contents. Whenever anything was given to it that was too hard to be broken by its teeth, it always looked about for a stone, and lifting it with one hand, by repeated blows would attempt to crack it: if unsuccessful by these means, it would try to find a larger stone, which it would hold in both its hands, and rising on its legs would let it fall, leaping back at the same time to avoid any injury to its toes. I have often watched the means it employed to obtain any small object that happened to be a little beyond its reach. If it could lay its hands upon a switch or slender twig of any sort, it would stretch itself out as far as its cord would allow, and continue working at the object till it got it within its reach. These operations were certainly often awkwardly performed, but they were always interesting from the amount of reasoning which the little animal exhibited, and the perseverance with which they were accompanied.—Gardner: *Travels in the Interior of Brazil.*

PROTECTIVE RESEMBLANCES AMONG ANIMALS.

Concealment, more or less complete, is useful to many animals, and absolutely essential to some. Those which have numerous

enemies from which they cannot escape by rapidity of motion, find safety in concealment. Those which prey upon others must also be so constituted as not to alarm them by their presence or their approach, or they would soon die of hunger. Now it is remarkable in how many cases Nature gives this boon to the animal, by colouring it with such tints as may best serve to enable it to escape from its enemies or to entrap its prey.

Desert animals, as a rule, are desert-coloured. The lion is a typical example of this, and must be almost invisible when crouched upon the sand or among desert rocks and stones. Antelopes are more or less sand-coloured. The camel is pre-eminently so. The Egyptian cat and the Pampas cat are sandy or earth-coloured. The Australian kangaroos are of the same tints, and the original colour of the wild horse is supposed to have been a sandy or clay-colour. The desert birds are still more remarkably protected by their assimilative hues. The stone-chats, the larks, the quails, the goat-suckers, and the grouse, which abound in the North African and Asiatic deserts, are all tinted and mottled so as to resemble with wonderful accuracy the average colour and aspect of the soil in the district they inhabit. The Rev. H. Tristram, in his account of the ornithology of North Africa, says: "In the desert, where neither trees, brush-wood, nor even undulations of the surface afford the slightest protection to an animal from its foes, a modification of colour which shall be assimilated to that of the surrounding country is absolutely necessary. Hence, without exception, every bird, whether lark, chat, sylvian, or sand-grouse, and also the fur of all the smaller mammals, and the skin of all the snakes and lizards, is of one uniform isabelline or sand-colour."

Almost equally striking are the cases of Arctic animals possessing the white colour that best conceals them upon snow-fields and icebergs. The polar bear is the only bear that is white, and it lives constantly among snow and ice. The Arctic fox, the ermine, and the Alpine hare change to white in winter only, because in summer white would be more conspicuous than any other colour, and therefore a danger rather than a protection; but

the American polar hare, inhabiting regions of almost perpetual snow, is white all the year round. Among birds the ptarmigan is a fine example of protective colouring. Its summer plumage so exactly harmonizes with the lichen-coloured stones among which it delights to sit, that a person may walk through a flock of them without seeing a single bird; while in winter its white plumage is an almost equal protection. The snow-bunting, the jerfalcon, and the snowy owl are also white-coloured birds inhabiting the Arctic regions, and there can be little doubt that their colouring is to some extent protective.

Nocturnal animals supply us with equally good illustrations. Mice, rats, bats, and moles possess the least conspicuous hues, and must be quite invisible at times when any light colour would be instantly seen. Owls and goat-suckers are of those dark mottled tints that best assimilate with bark and lichen, and thus protect them during the day, and at the same time render them inconspicuous in the dark.

It is only in the tropics, among forests which never lose their foliage, that we find whole groups of birds whose chief colour is green. The parrots are the most striking example, but we have also a group of green pigeons in the East; and the barbets, leaf-thrushes, bee-eaters, white-eyes, turācos, and several smaller groups, have so much green in their plumage as to tend greatly to conceal them among foliage.

The conformity of tint which has been so far shown to exist between animals and their habitations is of a somewhat general character; we will now advert to some cases of more special adaptation. If the lion is enabled by his sandy colour readily to conceal himself by merely crouching upon the desert, how, it may be asked, do the elegant markings of the tiger, the jaguar, and the other large cats, agree with this theory? We reply that these are generally cases of more or less special adaptation. The tiger is a jungle animal, and hides himself among tufts of grass or of bamboos, and in these positions the vertical stripes with which his body is adorned must so assimilate with the vertical stems of the bamboo as to assist greatly in concealing him from the

approaching prey. How remarkable it is that, besides the lion and tiger, almost all the other large cats are arboreal in their habits, and almost all have ocellated or spotted skins, which must certainly tend to conceal them with a background of foliage; while the one exception, the puma, has an ashy-brown uniform fur, and has the habit of clinging so closely to a limb of a tree, while waiting for his prey to pass beneath, as to be hardly distinguishable from the bark!

Among birds, the ptarmigan, already mentioned, must be considered a remarkable case of special adaptation. In the case of the woodcock, the various browns and yellows and pale ash-colour that occur in fallen leaves are all reproduced in its plumage, so that when, according to its habit, it rests upon the ground under trees, it is almost impossible to detect it. In snipes the colours are modified so as to be equally in harmony with the prevalent forms and colours of marshy vegetation.

Reptiles offer us many similar examples. The most arboreal lizards, the iguanas, are as green as the leaves they feed upon; and the slender whip-snakes are rendered almost invisible as they glide among the foliage by a similar colouration. There is a North American frog found on lichen-covered rocks and walls, which is so coloured as exactly to resemble them, and as long as it remains quiet will certainly escape detection. Some of the geckos which cling motionless to the trunks of trees in the tropics are of such curiously marbled colours as to match exactly with the bark they rest upon. In every part of the tropics there are tree-snakes that twist among boughs and shrubs, or lie coiled up in the dense masses of foliage. These are of many distinct groups, and comprise both venomous and harmless genera; but almost all of them are of a beautiful green colour, sometimes more or less adorned with white or dusky bands and spots. There can be no doubt that this colour is doubly useful to them, since it will tend to conceal them from their enemies, and will lead their prey to approach them unconscious of danger.

Fishes present similar instances. Many flat fish—as, for example, the flounder and the skate—are exactly the colour of the gravel or

sand on which they habitually rest. Among the marine flower-gardens of an Eastern coral-reef the fishes present every variety of gorgeous colour, while the river fish even of the tropics rarely if ever have gay or conspicuous markings. A very curious case of this kind of adaptation occurs in the sea-horses (*Hippocampus*) of Australia, some of which bear long foliaceous appendages resembling sea-weed, and of a brilliant red colour; and they are known to live among sea-weed of the same hue, so that when at rest they must be quite invisible.

It is, however, in the insect world that this principle of the adaptation of animals to their environment is most fully and strikingly developed. In the tropics there are thousands of species of insects which rest during the day by clinging to the bark of dead or fallen trees; and the greater number of these are delicately mottled with gray and brown tints, which, though symmetrically disposed and infinitely varied, yet blend so completely with the usual colours of the bark, that at a distance of two or three feet they are quite undistinguishable. A number of our small brown and speckled weevils, at the approach of any object roll off the leaf they are sitting on, at the same time drawing in their legs and antennæ, which fit so perfectly into cavities for their reception that the insect becomes a mere oval brownish lump, which it is hopeless to look for among the similarly coloured little stones and earth pellets among which it lies motionless. The whole order of *Orthoptera*—grasshoppers, locusts, crickets, &c.—are protected by their colours harmonizing with that of the vegetation or the soil on which they live, and in no other group have we such striking examples of special resemblance. Most of the tropical *Mantidæ* and *Locustidæ* are of the exact tint of the leaves on which they habitually repose; and many of them in addition have the veining of their wings modified so as exactly to imitate that of a leaf. This is carried to the furthest possible extent in the wonderful genus *Phyllium*, the "walking-leaf," in which not only are the wings perfect imitations of leaves in every detail, but the thorax and legs are flat, dilated, and leaf-like; so that when the living insect is resting among the foliage on which

it feeds, the closest observation is often unable to distinguish between the animal and the vegetable. The whole family of the *Phasinidæ*, or spectres, to which this insect belongs, is more or less imitative; and a great number of the species are called "walking-stick insects," from their singular resemblance to twigs and branches. Some of these are a foot long, and as thick as one's finger; and their whole colouring, form, rugosity, and the arrangement of the head, legs, and antennæ are such as to render them absolutely identical in appearance with dead sticks. They hang loosely about shrubs in the forest, and have the extraordinary habit of stretching out their legs unsymmetrically, so as to render the deception more complete.—*Abridged from Westminster Review for July* 1867.

THE FLIGHT OF BIRDS.

There are two facts observable in all birds of great and long-sustained powers of flight: the first is, that they are always provided with wings which are rather long than broad, sometimes extremely narrow in proportion to their length; the second is, that the wings are always sharply pointed at the ends. Let us look at the mechanical laws which absolutely require this structure for the purpose of powerful flight, and to meet which it has accordingly been devised and provided.

One law appealed to in making wings rather long than broad is simply the law of leverage. But this law has to be applied under conditions of difficulty and complexity, which are not apparent at first sight. The body to be lifted is the very body that must exert the lifting power. The force of gravity which has to be resisted may be said to be sitting side by side, occupying the same particles of matter, with the vital force which is to give it battle. Nay, more; the one is connected with the other in some mysterious manner which we cannot trace or understand. A dead bird weighs as much as a living one. Nothing which our scales can measure is lost when the "vital force" is gone. It is the Great Imponderable. Nevertheless, vital forces of

unusual power are always coupled with unusual mass and volume in the matter through which they work. And so it is that a powerful bird must always also be comparatively a heavy bird. And then it is to be remembered that the action of gravity is constant and untiring. The vital force, on the contrary, however intense it may be, is intermitting and capable of exhaustion. If, then, this force is to be set against the force of gravity, it has much need of some implement through which it may exert itself with mechanical advantage as regards the particular purpose to be attained. Such an implement is the lever; and a long wing is nothing but a long lever. The mechanical principle, or law, as is well known, is this—that a very small amount of motion, or motion through a very small space, at the short end of a lever, produces a great amount of motion, or motion through a long space, at the opposite or longer end. This action requires, indeed, a very intense force to be applied at the shorter end, but it applies that force with immense advantage for the purpose in view; because the motion which is transmitted to the end of a long wing is a motion acting at that point through a long space, and is therefore equivalent to a very heavy weight lifted through a short space at the end which is attached to the body of the bird. Now, this is precisely what is required for the purpose of flight. The body of a bird does not require to be much lifted by each stroke of the wing. It only requires to be sustained; and when more than this is needed—as when a bird first rises from the ground or from the sea, or when it ascends rapidly in the air—greatly increased exertion, in many cases very violent exertion, is required. And then it is to be remembered that long wings economize the vital force in another way. When a strong current of air strikes against the wings of a bird, the same sustaining effect is produced as when the wing strikes against the air. Consequently birds with very long wings have this great advantage, that with pre-acquired momentum, they can often for a long time fly without flapping their wings at all. Under these circumstances, a bird is sustained very much as a boy's kite is sustained in the air. The string which the boy

holds, and by which he pulls the kite downwards with a certain force, performs for the kite the same offices which its own weight and balance and momentum perform for the bird. The great long-winged oceanic birds often appear to float rather than to fly. The stronger the gale, their flight, though less rapid, is all the more easy — so easy, indeed, as to appear buoyant; because the blasts which strike against their wings are enough to sustain the bird with comparatively little exertion of its own, except that of holding the wing vanes stretched and exposed at proper angles to the wind. And whenever the onward force previously acquired by flapping becomes at length exhausted, and the ceaseless inexorable force of gravity is beginning to overcome it, the bird again rises by a few easy and gentle half-strokes of the wing. Very often the same effect is produced by allowing the force of gravity to act; and when the downward momentum has brought the bird close to the ground or to the sea, that force is again converted into an ascending impetus by a change in the angle at which the wing is exposed to the wind. This is a constant action with all the oceanic birds. Those who have seen the albatross have described themselves as never tired of watching its glorious and triumphant motion:

> "Tranquil its spirit seemed, and floated slow;
> Even in its very motion there was rest."

Rest, where there is nothing else at rest in the tremendous turmoil of its own stormy seas! Sometimes for a whole hour together this splendid bird will sail or wheel round a ship, in every possible variety of direction, without requiring to give a single stroke to its pinions. Now, the albatross has the extreme form of this kind of wing. Its wings are immensely long—about fourteen or fifteen feet from tip to tip—and almost as narrow in proportion as a ribbon. Our common gannet is an excellent, though a more modified, example of the same kind of structure. On the other hand, birds of short wings, though their flight is sometimes very fast, are never able to sustain it very long. The muscular exertion they require is greater, because it does not

work to the same advantage. Most of the gallinaceous birds (such as the common fowl, pheasants, partridges, &c.) have wings of this kind; and some of them never fly except to escape an enemy or to change their feeding ground.

The second fact observable in reference to birds of easy and powerful flight—namely, that their wings are all sharply pointed at the end—will lead us still further into the niceties of adjustment which are so signally displayed in the machinery of flight.

The feathers of a bird's wing have a natural threefold division, according to the different wing-bones to which they are attached. The quills which form the end of the wing are called the primaries; those which form the middle of the vane are called the secondaries; and those which are next the body of the bird are called the tertiaries. The motion of a bird's wing increases from its minimum at the shoulder-joint to its maximum at the tip. The primary quills, which form the termination of the wing, are those on which the chief burden of flight is cast. Each feather has less and less weight to bear, and less and less force to exert in proportion as it lies nearer the body of the bird; and there is nothing more beautiful in the structure of a wing than the perfect gradation in strength and stiffness, as well as in modification of form, which marks the series from the first of the primary quills to the last and feeblest of the tertiaries. Now, the sharpness or roundness of a wing at the tip depends on the position which is given to the *longest* primary quill. If the first or even the second primary is the longest, and all that follow are considerably shorter, the wing is necessarily a pointed wing, because the tip of a single quill forms the end; but if the third and fourth primary quills are the longest, and the next again on both sides are only a little shorter, the wing becomes a round-ended wing. Round-ended wings are also almost always open-ended; that is to say, the tips of the quills do not touch each other, but leave interspaces at the end of the wing, through which, of course, a good deal of air escapes. Since each single quill is formed on the same principle as the whole wing—that is, with the anterior margin stiff and the posterior margin yielding—this escape is not

useless for progression; but the air acts less favourably for this purpose than when struck by a more compact set of feathers. The common rook and all the crows are examples of this. The peregrine falcon, the common swallow, and all birds of very powerful flight, have been provided with the sharp-pointed structure.—*Abridged from the* DUKE OF ARGYLL'S *Reign of Law.*

THE LIMPET.

HERE are the familiar Limpets (*Patella vulgata*), too: let us look at them awhile. They are not generally very attractive in appearance, the shell being coarse and rubbed, especially in the larger specimens; and in an aquarium they do not live long, and are so inert as to afford no amusement even while they survive. Yet we occasionally find examples prettily coloured; and there are facts in their economy which make them worthy of a few moments' notice.

If you look carefully over the rocks, especially when these are of a somewhat soft nature, as the slates and shales, you will find oval depressions, sometimes just discernible, at other times sunk to the depth of an eighth of an inch, corresponding in outline to the shell of a limpet; and in many instances you will actually see a limpet embedded in such a pit, which it accurately fills. Strange as it may seem, it has been ascertained that these cavities are formed by the animals, which make them their ordinary resting-places, wandering away from them nightly to feed, and returning to them to rest early in the morning.

The force with which a limpet adheres to the rock is very great, especially when it has had warning of assault, and has had time to put out its muscular strength. Réaumur found that a weight of twenty-eight or thirty pounds was required to overcome this adhesive force. His experiments seem to prove, however, that its power is mainly owing, not to muscular energy, nor to the production of a vacuum in the manner of a sucker. When an adhering limpet was cut quite through perpendicularly, shell and

animal, the two parts maintained their hold with unabated force, although, of course, a vacuum, if there had been one, would have been destroyed by the incision. The power is said to reside in a very strong glue, a very viscid secretion, deposited at the will of the animal. "If, having detached a *Patella*," says Dr. Johnston, "the finger be applied to the foot of the animal, or to the spot on which it rested, the finger will be held there by a very sensible resistance, although no glue is perceptible. And it is remarkable that if the spot be now moistened with a little water, or if the base of the animal be cut, and the water contained in it allowed to flow over the spot, no further adhesion will occur on the application of the finger: the glue has been dissolved. It is Nature's solvent, by which the animal loosens its own connection with the rock. When the storm rages, or when an enemy is abroad, it glues itself firmly to its rest; but when the danger has passed, to free itself from this forced constraint, a little water is pressed from the foot, the cement is weakened, and it is at liberty to raise itself and be at large. The fluid of cementation, as well as the watery solvent, is secreted in an infinity of miliary glands with which the foot is, as it were, shagreened; and as the limpet cannot supply the secretion as fast as this can be exhausted, you may destroy the animal's capacity of fixation by detaching it forcibly two or three times in succession."

If we remove one of these limpets from his selected area of rock—which we may readily do, notwithstanding the strength of his cement, if we take him at unawares, and give him a smart, sudden, horizontal knock with a piece of wood, or a moderated blow with a hammer—we shall obtain a view of a structure well worth looking at. One of the most curious peculiarities in the limpet is its gill or breathing organ. This, we perceive, completely encircles the animal, forming a ring interrupted only at one point. It lies in the fold between the mantle and the foot, commencing on the left side of the neck, and passing quite round the body, parallel with the edge of the shell, in front of the head, till it terminates close to the point where it began. It is a long cord closely beset with tiny leaflets, and thus forming a

continual plume. Each leaflet, conical in outline, is permeated with blood-vessels, and clothed with minute *cilia* (eye-lash like filaments), whose constant vibrations cause the circumambient water ever to play over the surface of these organs in ceaseless currents, bringing fresh supplies of oxygen to be respired; and this is absorbed by the blood through the thin membrane by which they are protected.—Gosse: *A Year at the Shore.*

HUMMING-BIRDS.

In January the orange-trees became covered with blossom—at least to a greater extent than usual, for they flower more or less in the tropical regions of South America all the year round—and the flowers attracted a great number of humming-birds. Every day, in the cooler hours of the morning, and in the evening from four o'clock till six, they were to be seen whirring about the trees by scores. Their motions are unlike those of all other birds. They dart to and fro so swiftly that the eye can scarcely follow them, and when they stop before a flower it is only for a few moments. They poise themselves in an unsteady manner, their wings moving with inconceivable rapidity, probe the flower, and then shoot off to another part of the tree. They do not proceed in the methodical manner which bees follow, taking the flowers seriatim, but skip about from one part of the tree to another in the most capricious way. Sometimes two males close with each other and fight, mounting upwards in the struggle as insects are often seen to do when similarly engaged, and then separating hastily and darting back to their work. Now and then they stop to rest, perching on leafless twigs, when they may be sometimes seen probing, from the place where they sit, the flowers within their reach. The brilliant colours with which they are adorned cannot be seen whilst they are fluttering about, nor can the different species be distinguished unless they have a deal of white hue in their plumage. There is not a great variety of humming-birds in the Amazons region, the number of species

being far smaller in these uniform forest plains than in the diversified valleys of the Andes, under the same parallels of latitude. The family is divisible into two groups contrasted in form and habits, one containing species which live entirely in the shade of the forest, and the other comprising those which prefer open sunny places. The forest species (*Phaethorninæ*) are seldom seen at flowers, flowers being, in the shady places where they abide, of rare occurrence; but they search for insects on leaves, threading the bushes and passing above and beneath each leaf with wonderful rapidity. The other group (*Trochilinæ*) are not quite confined to cleared places, as they come into the forest wherever a tree is in blossom, and descend into sunny openings where flowers are to be found. But it is only where the woods are less dense than usual that this is the case; in the lofty forests and twilight shades of the low lands and islands they are scarcely ever seen.

Several times I shot by mistake a humming-bird hawk-moth instead of a bird. This moth (*Macroglossa Titan*) is somewhat smaller than humming-birds generally are, but its manner of flight, and the way it poises itself before a flower whilst probing it with its proboscis are precisely like the same actions of humming-birds. It was only after many days' experience that I learned to distinguish one from the other when on the wing. This resemblance has attracted the notice of the natives, all of whom, even educated whites, firmly believe that one is transmutable into the other. They have observed the metamorphosis of caterpillars into butterflies, and think it not at all more wonderful that a moth should change into a humming-bird. The resemblance between this hawk-moth and a humming-bird is certainly very curious, and strikes one even when both are examined in the hand. Holding them sideways, the shape of the head and position of the eyes in the moth are seen to be nearly the same as in the bird, the extended proboscis representing the long beak. At the tip of the moth's body there is a brush of long hair-scales resembling feathers, which, being expanded, looks very much like a bird's tail. But, of course, all these points of resemblance are

merely superficial. The Negroes and Indians tried to convince me that the two were of the same species. "Look at their feathers," they said; "their eyes are the same, and so are their tails." This belief is so deeply rooted that it was useless to reason with them on the subject. The Macroglossa moths are found in most countries, and have everywhere the same habits; one well-known species is found in England, and is there often mistaken for a humming-bird.

It has been observed that humming-birds are unlike other birds in their mental qualities, resembling in this respect insects rather than warm-blooded vertebrate animals. The want of expression in their eyes, the small degree of versatility in their actions, the quickness and precision of their movements, are all so many points of resemblance between them and insects. In walking along the alleys of the forest a Phaethornis frequently crosses one's path, often stopping suddenly and remaining poised in mid-air, a few feet distant from the face of the intruder. The Phäethorninæ are certainly more numerous in individuals in the Amazons region than the Trochilinæ. They build their nests, which are made of fine vegetable fibres and lichens, densely woven together and thickly lined with silk-cotton from the fruit of the samaüma tree (*Eriodendron samaüma*), on the inner sides of the tips of palm fronds. They are long and purse-shaped. The young when first hatched have very much shorter bills and less brilliant plumage than their parents, but in a few months assume all the aspects of, and are undistinguishable from the adult bird. —*Abridged from* BATES's *Naturalist on the River Amazons.*

REASON IN ANIMALS.

THERE is a little spider called the water-spider, which actually constructs a diving-bell, not only upon the most scientific principles, but in so mysterious and recondite a manner that natural philosophers have not even yet discovered the secret of its patent. This diving-bell is a little cylinder lined with silk, and fastened

with threads on every side to the water-plants. It is open only below, so that the spider has to dive under the water before it can get into it. But when it is in, how can it live unless there be air? It solves this difficulty in a manner that puzzles the philosophers. It carries down, round its body, a bubble of air, and lets it escape at the mouth of the bell; the air ascends to the top of the bell, and displaces a quantity of water equal to its own bulk. The spider goes on diving with these air bubbles until it has filled the diving-bell with air, and being now furnished with an atmosphere, and secure from all molestation from without, it rejoices in the seclusion of its own domestic retirement. But the question is, how does the little animal discover this ingenious and intricate process of house-building, so far beyond the inventive powers of man himself? No doubt it is furnished with an apparatus for carrying the air-bubble, and with power to force itself under the water with air-bladders around it. But how it comprehends the manner of using the apparatus, shaping the bell, fastening it, making its opening in the water instead of in the air, and then filling it with an invisible gas, is a problem difficult of solution.

The industry and ingenuity of mason-bees, mining-bees, carpenter-bees, and wasps—upholsterer, carder, lapidary, and humble-bees, and social wasps—the carpentry of tree-hoppers and saw-flies—the ingenuity of leaf-rolling, nest-building, carpenter, tent-making, and stone-mason caterpillars—the extraordinary architecture of ants of every description, the galleries which they excavate in trees, the towers which they build, the government which they organize, their military establishments, their nurseries, and their "maiden ants," or females exclusively set apart, like the nuns of the Roman Catholics, for superintending the nurture and admonition of the young—the almost infinite variety of modes of industry exhibited by worms, moths, and spiders, and many other classes of articulated animals, are all so many illustrations of the wonders of instinct in contradistinction to reason, or intelligence derived from experience.

Instances, however, might be brought forward which inevi-

tably imply that animals possess and evince faculties precisely of the same kind as those of man, differing from him in degree only. The following instance of an elephant is to the point:— An officer in the Indian army, who was quarter-master of a brigade, found it needful to put a heavier load than usual on a very large elephant, called the Paugul, or fool; but he soon intimated that he was only disposed to take his usual load. The officer, seeing the animal repeatedly shake off the superabundant portion, lost his temper, and threw a tent-pin at the animal's head. Some days after, as the latter was going with others to water, he happened to pass the officer, whom he very deliberately lifted up into a large tamarind tree, leaving him to cling to the boughs, and to get down as well as he could.

It is instinct which compels the swallow to migrate—instinct which, with mysterious finger, points the eyes of the helpless flutterer to the luxurious swamps of Africa, where its insect food may be found in plenty when winter has locked up the forests of its home. The following is given on the authority of Cuvier, and derives additional interest from the fact that it first served to draw his attention to natural history as a pursuit. While he was a young man a pair of swallows built their nest on one of the angles of the casement of his apartment. During their temporary absence it was taken possession of by a pair of sparrows, who persisted in remaining in it, and resisted every effort of its rightful owners to regain it. After a time crowds of swallows gathered upon the roof, among whom were recognized the exiled pair, who seemed to be informing their friends of the outrage they had suffered. The whole assembly was in a state of great commotion, and appeared highly incensed, as was manifested by their movements and cries. Before long, suddenly, and swift as thought, a host of them flew against the nest. Each bore in his bill a small quantity of mud, which he deposited at its entrance, and then gave way for another, who repeated the operation. This was continued till the opening was completely closed up, and the marauders were buried in a living tomb. The labours of this friendly company, however, did not cease here; they im-

mediately collected materials for another nest, which they built just over the entrance to the first. In less than two hours after the act of vengeance had been consummated, the new structure was completed and inhabited.

These deviations from instinctive action, observed so frequently in the history of the lower animals, are at the same time the most entertaining and the most conclusive on the point of the possession of intellect.—A shepherd intrusted a flock of eighty sheep to his dog alone, to be driven home, a distance of seventeen miles. On the road she was delivered of a couple of pups. Notwithstanding this incumbrance, and though faithful to her maternal instinct, she was not neglectful of her task. By carrying her young a few miles in advance of her flock whilst it was feeding, and then driving it on beyond them, she at length reached the end of her journey; as it turned out, however, at the sacrifice of the lives of her offspring.—A wren in the Penrhyn Slate Quarries used to fly from her nest on the ringing of a bell, which gave notice to the workmen that an explosion was to take place. In order to exhibit this phenomenon to strangers who visited the place, the bell was often rung at other times. At first the bird left her nest as before, but after a time paid no attention to the signal, except when she observed that the workmen also went away as they had usually done.—A horse came home without his driver, but instead of going directly to the stable, stopped at the house, neighed, and exhibited other indications of great disquietude. This at first excited no attention, but as these manifestations continued, and his master did not appear, apprehension was excited, and a person despatched in search of him. He was found two miles off, lying insensible, in consequence of a severe blow upon the head, which he had received by falling from his cart.

Several instances are on record where animals have "played the dead man;" an act inevitably implying the possession of something higher than instinctive impulse as its cause. Mr. Blythe relates the story of a fox who personated a defunct carcass when surprised one day in a hen-house, and played the part

so well as to suffer himself to be taken by the brush and thrown on a dunghill; when, carefully opening one eye and seeing the coast clear, he took to his heels and escaped, leaving his human dupe to speculate on the artistic perfection of the performance. Indeed this cunning animal has been known to submit to be carried as dead for more than a mile, till at length, getting weary of his uncomfortable position, or *reasoning* that escape was both possible and advisable, he suddenly effected it by a vigorous snap at the hand which held him. Cats have been known to feign death on a grass-plot while swallows were skimming across it, and by this trick succeed in capturing some unfortunate bird which chanced to come too near. Even insects will put on the semblance of death when their lives are in danger.

Mr. Darwin tells us that there was, not many years ago, an old monkey at Exeter 'Change that had lost all his teeth. Visitors were in the habit of giving him nuts, but the old fellow was unable to crack them. He was furnished with a stone, and would thus break them on the floor of his prison. Crows and rooks have been known to rise in the air with a mussel in their beaks, and to drop it on a rock in order to break it, so as to enable them to feed on its contents. "I have heard of a jackdaw," says Jesse, "who was seen to drop stones in a hole in which there was some water, which it could not reach till the water was raised sufficiently high to enable it to quench its thirst." "I have also known," says the same entertaining naturalist, "a cat, when she was shut up in a room and wanted to get out, ring the bell and make her escape when the servant answered it." Another cat, in a house where it was the custom to ring a bell before the meals, one day chanced to be shut up at dinner-time. Some hours after, when she was let out, she ran to the room where they used to put her food, but it was not there. Soon after the people heard a bell ringing, and came to see what was the matter. When the door was opened, what was their surprise to see the cat clinging to the bell-rope. The fact was that puss wanted her dinner, and having always seen that it was brought after the ringing of the bell, she *thought* she would ring it herself.

Monkeys are very fond of birds' eggs. In some countries where these animals abound, birds, in order to preserve their eggs, make their nests at the ends of the slender branches of trees, so that the monkeys cannot reach them. Woodpeckers carefully remove the bits of wood which they break off a tree while making a hole in it for their nest—evidently to prevent persons discovering their abode. For the same reason many birds carefully remove the excrement of their young from the neighbourhood of the nests. Man himself could not be more calculating and far-reaching.—*Abridged from Once a Week.*

MOTIONS AND GAITS OF BIRDS.

A good ornithologist should be able to distinguish birds by their air as well as by their colours and shape, on the ground as well as on the wing, and in the bush as well as in the hand. For though it must not be said that every species of bird has a manner peculiar to itself, yet there is somewhat in most genera at least that at first sight discriminates them, and enables a judicious observer to pronounce upon them with some certainty.

Thus kites and buzzards sail round in circles, with wings expanded and motionless; and it is from their gliding manner that the former are still called, in the north of England, gledes, from the Saxon verb *glidan*, to glide. The kestrel, or windhover, has a peculiar mode of hanging in the air in one place, his wings all the while being briskly agitated. Hen-harriers fly low over heaths and fields of corn, and beat the ground regularly like a pointer or setting dog. Owls move in a buoyant manner, as if lighter than the air: they seem to want ballast. There is a peculiarity belonging to ravens that must draw the attention even of the most incurious: they spend all their leisure time in striking and cuffing each other on the wing in a kind of playful skirmish; and when they move from one place to another, frequently turn on their backs with a loud croak, and seem to be falling to the ground. When this odd gesture betides them,

they are scratching themselves with one foot, and thus lose the centre of gravity. Rooks sometimes dive and tumble in a frolicsome manner; crows and daws swagger in their walk; woodpeckers fly, opening and closing their wings at every stroke, and so are always rising and falling in curves. All of this genus use their tails, which incline downwards, as a support while they run up trees. Parrots, like all other hook-clawed birds, walk awkwardly, and make use of their bill as a third foot, climbing and descending with ridiculous caution.

All the Poultry kind parade and walk gracefully, and run nimbly; but fly with difficulty, with an impetuous whirring, and in a straight line. Magpies and jays flutter with powerless wings, and make no despatch. Herons seem incumbered with too much sail for their light bodies; but those vast hollow wings are necessary in carrying burdens, such as large fishes, and the like. Pigeons, and particularly the sort called smiters, have a way of clashing their wings, the one against the other, over their backs, with a loud snap; another variety, called tumblers, turn themselves over in the air. Some birds have movements peculiar to the season of love: thus ring-doves, though strong and rapid at other times, yet in the spring hang about on the wing in a toying and playful manner; thus the cock-snipe, while breeding, forgetting his former flight, fans the air like a windhover; and the greenfinch, in particular, exhibits such languishing and faltering gestures as to appear like a wounded and dying bird: the king-fisher darts along like an arrow; fern-owls, or goat-suckers, glance in the dusk over the tops of trees like a meteor; starlings, swim along, as it were, while missel-thrushes use a wild and desultory flight: swallows sweep over the surface of the ground and water, and distinguish themselves by rapid turns and quick evolutions; swifts dash round in circles; and the bank-martin moves with frequent vacillations like a butterfly.

Most of the small birds fly by jerks, rising and falling as they advance. Most small birds hop; but wagtails and larks walk, moving their legs alternately. Sky-larks rise and fall perpendicularly as they sing; woodlarks hang poised in the air; and tit-

larks rise and fall in large curves, singing in their descent. The white-throat uses odd jerks and gesticulations over the tops of hedges and bushes. All the duck kind waddle: divers and auks walk as if fettered, and stand erect on their tails; these are the *compedes* of Linnæus. Geese and cranes, and most wild-fowls, move in figured flights, often changing their position. The secondary wing-feathers of rails, wild ducks, and some others, are very long, and give their wings, when in motion, a hooked appearance. Dab-chicks, moor-hens, and coots, fly erect, with their legs hanging down, and hardly make any despatch. The reason is plain: their wings are placed too forward, out of the true centre of gravity; as the legs of auks and divers are situated too backward.—*Abridged from* WHITE'S *Natural History of Selborne.*

LANGUAGE OF BIRDS.

FROM the motion of birds, the transition is natural enough to their notes and language, of which I shall say something. Not that I would pretend to understand their language like the vizier, who, by the recital of a conversation which passed between two owls, reclaimed a sultan, before delighting in conquest and devastation; but I would be thought only to mean, that many of the winged tribes have various sounds and voices, adapted to express their various passions, wants, and feelings—such as anger, fear, love, hatred, hunger, and the like. All species are not equally eloquent: some are copious and fluent, as it were, in their utterance, while others are confined to a few important sounds; no bird, like the fish kind, is quite mute, though some are rather silent. The language of birds is very ancient, and, like other ancient modes of speech, very elliptical; little is said, but much is meant and understood.

The notes of the eagle kind are shrill and piercing; and about the season of nidification much diversified, as I have been often assured by a curious observer of Nature, who long resided at Gibraltar, where eagles abound. The notes of our hawks much

resemble those of the king of birds. Owls have very expressive notes: they hoot in a fine vocal sound, much resembling the human voice, and reducible by a pitch-pipe to a musical key. This note seems to express complacency and rivalry among the males. They use also a quick call and a horrible scream; and can snore and hiss when they mean to menace. Ravens, besides their loud croak, can exert a deep and solemn note that makes the woods to echo; the amorous sound of a crow is strange and ridiculous; rooks, in the breeding season, attempt sometimes, in the gaiety of their hearts, to sing, but with no great success; the parrot kind have many modulations of voice, as appears by their aptitude to learn human sounds; doves coo in an amorous and mournful manner, and are emblems of despairing lovers; the woodpecker sets up a sort of loud and hearty laugh; the fern-owl, or goat-sucker, from the dusk till day-break, serenades his mate with the clattering of castanets. All the tuneful song-birds express their complacency by sweet modulations, and a variety of melody. The swallow, by a shrill alarm, bespeaks the attention of its fellows, and bids them be aware that the hawk is at hand. Aquatic and gregarious birds, especially the nocturnal, that shift their quarters in the dark, are very noisy and loquacious; as cranes, wild-geese, wild-ducks, and the like: their perpetual clamour prevents them from dispersing and losing their companions.

In so extensive a subject, sketches and outlines are as much as can be expected: we shall, therefore, confine the remainder of our remarks to the few domestic fowls of our yards, which are most known, and therefore best understood. And first, the peacock, with his gorgeous train, demands our attention; but, like most of the gaudy birds, his notes are grating and shocking to the ear—the yelling of cats, and the braying of an ass, are not more disgustful. The voice of the goose is trumpet-like, and clanking; and once saved the Capitol at Rome, as grave historians assert: the hiss also of the gander is formidable, and full of menace, and "protective of his young." Among ducks, the sexual distinction of voice is remarkable; for

while the quack of the female is loud and sonorous, the voice of the drake is inward, and harsh, and feeble, and scarcely discernible. The cock-turkey struts and gobbles to his mistress in a most uncouth manner; he has also a pert and petulant note when he attacks his adversary. When a hen-turkey leads forth her young brood, she keeps a watchful eye; and if a bird of prey appear, though ever so high in the air, the careful mother announces the enemy with a little inward moan, and watches him with a steady and attentive look; but if he approach, her note becomes earnest and alarming, and her outcries are redoubled.

No inhabitants of a yard seem possessed of such a variety of expression, and so copious a language, as common poultry. Take a chicken of four or five days old, and hold it up to a window where there are flies, and it will immediately seize its prey with little twitterings of complacency; but if you tender it a wasp or a bee, at once its note becomes harsh and expressive of disapprobation and a sense of danger. When a pullet is ready to lay, she intimates the event by a joyous and easy soft note. Of all the occurrences of their life, that of laying seems to be the most important; for no sooner has a hen disburdened herself than she rushes forth with a clamorous kind of joy, which the cock and the rest of his mistresses immediately adopt. The tumult is not confined to the family concerned, but catches from yard to yard, and spreads to every homestead within hearing, till at last the whole village is in an uproar. As soon as a hen becomes a mother her new relation demands a new language; she then runs clucking and screaming about, and seems agitated as if possessed. The father of the flock has also a considerable vocabulary: if he finds food, he calls a favourite concubine to partake; and if a bird of prey passes over, with a warning voice he bids his family beware. The gallant chanticleer has at command his amorous phrases and his terms of defiance, but the sound by which he is best known is his crowing: by this he has been distinguished in all ages as the countryman's clock or larum—as the watchman that proclaims the divisions of the night.—*Abridged from* WHITE'S *History of Selborne.*

PHYSIOLOGICAL.

PHYSIOLOGY.

Physiology in its widest sense (Gr. *physis*, nature; and *logos*, discourse or reasoning) embraces all that can be known of the phenomena, forces, and laws of the natural world, and in this meaning comprehends at once the inorganic and organic kingdoms. In its usual and more restricted sense, it refers to organic nature only; embracing the study of the organs of plants and animals—the structure of these organs, the causes which excite them to action, and the functions or duties they have to perform. We have thus *Vegetable Physiology* and *Animal Physiology*;—the former directing itself to the consideration of the organs of growth, nutrition, and reproduction in plants (roots, sap-vessels, leaves, flowers, fruits, &c.); and the latter to the consideration of the organs of respiration, nutrition, circulation, and reproduction in animals (muscles, nerves, lungs, heart, veins, arteries, &c.).

As Botany is the science of plant life, and Zoology that of animal life, so the term *Biology* (Gr. *bios*, life; and *logos*) embraces both, and refers to the study of Life in all its multifarious manifestations and developments. Biology is thus occasionally used as synonymous with Physiology; but in general the latter is regarded as a department of the former—that department which treats of the vital actions or *functions* performed by the organs of plants and animals when in their healthy or normal condition. Physiology is thus a science of vast importance, and lies at the foundation of all sound knowledge relating to the laws which govern the healthy life and growth of plants and animals; or, in

other words, to the conditions under which the organs of both can best discharge the functions they are naturally destined to fulfil. As Physiology relates to the *functions* of vital organs, so *Morphology* (Gr. *morphé*, form; and *logos*) takes cognizance merely of the form, the order, and the arrangement of these organs: and as Physiology treats of the healthy action of organs, so *Pathology* (Gr. *pathos*, suffering or disease; and *logos*) treats of these organs in a diseased or unhealthy condition. A knowledge of Physiology is thus indispensable to the physician and scientific gardener; and while indispensable to the professional man, some acquaintance with its leading facts must be of great value to all who would either in themselves enjoy the indescribable pleasure of a healthy existence, or be the means of securing it for others. The laws which govern the organic world are fixed and enduring as those which regulate the inorganic; and there can be no harmonious development of life unless under strict compliance with the order, regularity, and conduct which those laws so imperatively require.

INFLUENCE OF THE SUN ON PHYSICAL LIFE—POLAR, TEMPERATE, AND TROPICAL.

The most powerful spring of physical life—the most active source, that which surpasses all the others—is the heat of that life-giving orb which the ancient poets sang, and the nations, forgetting the only true Creator of all things, adored as the parent of nature. But in virtue of the spherical form of the Earth, each district of the surface receives an unequal portion. Slanting, scattered, and feeble in the regions neighbouring the poles, the beams of the sun assume more strength and fall thicker in the middle regions; in those of the equator only they gain all their intensity, all their splendour. Now in this same proportion we see the development of life increase in energy and variety, from the poles to the equator.

What do we, in reality, see in the polar and frozen regions of

the North? During the greater part of the year, life seems almost extinguished by the excessive cold of a rigorous winter. A colourless and stunted vegetation; a few creeping shrubs—none of those stately forests which everywhere make the ornament of the landscape; endless plains, covered with mosses and lichens, composed of only a few species, notwithstanding the immense number of their individuals,—this is the flora of the cold regions. The preponderance of the cryptogamous plants—that is, of the flowerless and inferior forms of vegetation—the small number of the genera and the species, the absence or scarcity of arborescent vegetation, give it that character of poverty and uniformity which strikes us so forcibly in those desolate lands. The animal kingdom, thanks to greater freedom of locomotion, is better represented; but the small number of types and the preponderance of marine animals, still keep up the character of inferiority not to be misunderstood.

In the temperate zones the number of genera and species is more than doubled; the superior types acquire a fuller development and more importance. In the vegetation, the preponderance in the phanerogamous or flowering plants, the beauty of the forests, the appearance of evergreen trees, are the signs of an immense progress. Meantime the soft tints, the modest forms, the winter sleep still interrupting the life of vegetation during long months, tell us that the triumph of life is not yet complete. The same progress goes on in animal life: the land animals prevail; the animal species become more numerous and more diverse.

But it is in the hot region of the tropics that the life of nature displays its fullest energy, its greatest diversity, its most dazzling splendours. We have already seen all that it can produce in those favoured countries of India and the Indian Archipelago, where all the conditions seem brought together to secure to physical life its richest development. The cryptogamous plants attain in the arborescent ferns the proportions of our forest trees. The grasses, which we only know in our climates under the humble forms they put on in our fields and pastures, rise, in

the elegant and majestic bamboo, to the height of sixty or seventy feet, and become real trees, the hard and hollow trunks of which serve for the construction of public edifices as well as for that of private houses. There, the entire forests seem double in height, and of a density unknown in our climates. A single tree is a garden, wherein a hundred different plants intertwine their branches, and display their brilliant flowers on a ground of verdure, where the varied lines and forms of their leaves are blended together. The number of the species, the beauty of the types, are not less astonishing. While in America the temperate zones of the two hemispheres scarcely furnish more than 4000 species of plants, the tropical region of that same continent has already made known more than 13,000; so that, probably, the comparatively narrow zone of the tropics contains much more than half of the vegetable species living on the surface of our continents. Nor is the animal kingdom less developed in this privileged zone. The boundless variety of species, the vivacity of the colours, the diversity of the shades, strike us in the insects and the birds. We admire the lofty stature and the strength of those huge pachyderms that people its forests and its rivers; the force and vigour of the ferocious inhabitants of the deserts of Africa and the Ganges. It is here, in fine, that Nature triumphs; here she displays herself in all her brilliancy.

Such is the law of the physical world. Nature goes on adding perfection to perfection, from the polar regions to the temperate zones, from the temperate zones to the region where the solar influence is felt in its greatest intensity.—GUYOT'S *Earth and Man.*

PHYSIOLOGICAL CHANGE.

THE body of the grown man presents to us the same unaltered aspect of form and size for long periods of time. With the exception of furrows deepening in the countenance, an adult man may seem hardly to alter for half a hundred years. But this

appearance is altogether illusory; for with apparent bodily identity there has really been an active and rapid change, daily and nightly, hourly and momently—an incessant waste and renewal of all the corporeal parts. A waterfall is permanent, and may present the same aspect of identity and unchangeableness from generation to generation, but who does not know that it is certainly made up of particles in a state of swift transition; the cataract is only a *form* resulting from the definite course which the changing particles pursue. The flame of a lamp presents to us for a long time the same appearance, but its constancy of aspect is caused by a ceaseless change in the place and condition of the chemical atoms which carry on combustion.

Just so with man: he appears an unchanged being, endowed with permanent attributes of power and activity, but he is really only an unvarying *form*, whose constituent particles are for ever changing. As each part of his body is brought into action, its particles perish, and are replaced by others; and thus destruction and renovation in the vital economy are indissolubly connected and proceed together. It is said, with reference to the casualties to which man is everywhere exposed, that "in the midst of life we are in death;" but physiologically this is a still profounder truth—we begin to die as soon as we begin to live.

Very few persons have any correct conception of the rate at which change goes on in their bodies. The average amount of matter taken into the system daily, under given circumstances, has been determined with a considerable degree of precision. From the army and navy diet-scales of France and England, which, of course, are based upon the recognized necessities of large numbers of men in active life, it is found that about $2\frac{1}{2}$℔ avoirdupois of dry food per day are required for each individual: of this, about three-quarters are vegetable and the rest animal. Assuming a standard of 140℔ as the weight of the body, the amount of oxygen consumed daily is nearly $2\frac{1}{2}$℔, which results from breathing about 25 or 30 hogsheads of air: the quantity of water is nearly $4\frac{1}{10}$℔ for the same time.

The weight of the entire blood of a full-grown man varies from

20 to 30lb; of this the lungs, in a state of health, contain about ½lb. The heart beats on an average 60 or 70 times in a minute. Every beat sends forward two ounces of the fluid. It rushes on at the rate of 150 feet in a minute, the whole blood passing through the lungs every two minutes and a half, or twenty times in an hour. In periods of great exertion the rapidity with which the blood flows is much increased, so that the whole of it sometimes circulates in less than a single minute! According to these data, all the blood in the body travels through the circulatory route 600 or 700 times in a day,—a total movement through the heart of 10,000 or 12,000lb of blood in 24 hours. At the same time there escape from the lungs nearly 2lb of *carbonic acid* and 1½lb of *watery vapour*. The *skin* loses by perspiration 2½lb of water, and there escape in other directions about 2¼lb of matter. In the course of a year, the amount of solid food consumed is upwards of 800lb: the quantity of oxygen is about the same; and that of water, taken in various forms, is estimated at 1500lb: or altogether a ton and a half of matter, solid, liquid, and gaseous, is ingested annually. We thus see that the adult of half a century has shifted the substance of his corporeal being more than a thousand times!

THE AIR WE BREATHE.

In respiration there are two objects to be considered, namely, the Air which is breathed, and the Breathing mechanism. This air, which no man can *see*, is nevertheless a very material substance. We stuff cushions with it, and the chemists analyze it into well-known substances. It forms an atmospheric ocean forty-five miles in height, surrounding our planet, and whirling with it as it whirls round the sun. It is an ocean subject to incessant fluctuations, or tides, as we may call them. Like the other ocean, it carries a variety of substances in its restless currents, but preserves a constant composition of its own, not affected by these substances. It is chiefly composed of two gases—*oxygen*, which

forms about one-fifth, and *nitrogen*, which forms nearly the remaining four-fifths; that is to say, there are twenty-one parts of oxygen to seventy-nine parts of nitrogen. But besides these, there is always a fraction of *carbonic acid gas* even in the purest atmospheric air: at ordinary elevations there are about two parts of carbonic acid in 5000 parts of air; so that we may reckon this gas as forming the $\frac{1}{2500}$ of the atmosphere. There are also traces of ammonia, but they are very slight.

The air of inhabited rooms, or of caves and dungeons, although constantly *tending* towards the standard of composition, is of course subject to great variations. The respiration of animals and plants, and the decay of organic matters, incessantly alter the composition of the air in these places, and unless these alterations be quickly counteracted by free access of fresh air, the result is an atmosphere *injurious* or *unbreathable*. The air is vitiated by its proportion of oxygen being lessened and its carbonic acid increased. It may be vitiated by other causes, such as the presence of injurious gases and effluvia, but the chief cause is the one just named.

When we breathe, and burn candles or lamps in a room, the breathing and the burning have a similar bad effect on the air, robbing it of oxygen and loading it with carbonic acid: there is neither breathing nor burning of candles without these effects. When Dalton analyzed the air of a room in which, during two hours, fifty candles had been burning, and two hundred persons breathing, he found that instead of the proportion of carbonic acid being only two gallons in five thousand of air (which would have been the proportion in the air of the street), it was not less than one gallon in every hundred! This air would soon have become unbreathable. Leblanc analyzed the atmosphere of three hospitals in Paris, and found that it contained five, ten, and twelve times as much carbonic acid as the air of the streets. . . .

Oxygen is the great inciter of vital changes; its presence is the indispensable condition of life. It is at once fuel and flame: it feeds and it destroys. Constantly withdrawn from the blood by the ceaseless activities of vital change, it is constantly drawn into

the blood by the process of respiration. If the blood rushing through our lungs does not meet there with a supply of oxygen, the torrent carries to the tissues venous in lieu of arterial blood, and the consequence is an arrest of all the vital changes. If in passing through the lungs the blood only meets with a small supply of oxygen, an imperfectly arterialized fluid is carried to the tissues, and a partial arrest takes place, which is seen in the diminished vigour of the organism: all the functions are depressed; and if this depression continue, death arrives. . . .

To absorb oxygen is an animal necessity. The blood, which is the great agent of nutrition, must constantly be supplied with oxygen from the air. It matters not whether the animal lives in air or in water—the real respiratory medium is the air—for water deprived of its air, or of its due proportion of oxygen, is as fatal to aquatic as to terrestrial animals. It matters not by what organ or surface the respiratory exchange takes place, it is always a twofold act of exhalation of carbonic acid on the one hand and of absorption of oxygen on the other.—*Adapted from* LEWES' *Physiology of Common Life.*

MALARIA: ITS NATURE AND EFFECTS.

ALTHOUGH the *effects* of malaria are at last pretty well known to our medical men, its mysterious nature and *origin* have never been hitherto unravelled; and whether it be an atmospheric agent, whether sulphuretted or carbonetted hydrogen gas, or whether it be a material or aëriform substance, is still unknown. Notwithstanding it is notorious for infesting rice and flax grounds, morasses and stagnant waters, the febrific tendencies of which are too well known, malaria exists independently of marshes and rank vegetation, in barren and apparently arid places. It may possibly be influenced by the drying power of the atmosphere, or the energy of evaporation under local causes, as expressed by the relation which the dew-point bears to the temperature of the atmosphere. The effluvia from marshes are presumed to indicate its presence; but even where a warning smell may exist, its

cause should be sought for, since it is as yet doubtful whether curing an effluvium of its scent also destroys its hurtful quality. Future discoveries may unveil the matter.

That the vagaries of malaria, as evinced in effects which display but little affinity with each other, are at present almost inscrutable, is no reason for a neglect of observation and inquiry. We are told of towns where one side of a street is infected, and the other not; of streets in which some houses alone escape; and even of barracks in which some divisions are healthy and others filled with sick men. But in these cases the anomaly is rather apparent than real: it may be owing to exposure of site here, or the prevalence of contagious disorders there; and sometimes the miasma has been known to rise from its marshy bed along the nearest side of the adjacent uplands, infecting all that it passed over, though becoming so rarified and dispersed as to lose its malignity at the summit. Over valleys the action is somewhat different: during the summer nights, the exhalations of the day are partly precipitated, and meeting those which for some time after sunset try to ascend, the two baneful gases concentrate. This is malaria of a most malignant type, and will be more or less pernicious according to the season of the year, and the predisposition of bodies exposed to its influence. This unseen enemy is also wafted by the winds to a considerable distance, contaminating the air of places not otherwise unhealthy, the virulence depending on local and aërial circumstances. As to season, it may be considered to prevail from the summer solstice to the autumnal equinox, when fevers, visceral complaints, and general bodily derangement, mark its presence; and it is even advanced by physicians living in the district, that at such times fatal epidemics among men, and epizootics among cattle, display on dissection the same appearances of inflammatory affection. The operation of malaria is not much dreaded during day-time, since all the emanations are dissipated by the solar beams. Evening causes more cases of fever even than midnight, when the poisonous exhalation is completely condensed upon the soil; and hence those who sleep in the upper stories of houses are less liable to

disease, and take it in a milder form, than those whose beds are on the ground floor. The time of sleep seems to be the moment of attack, as the debility of the body and the peculiar state of the local night air combine to aid the effective reception of miasma. Foulness of stomach excites redundant bile, and consequently lays the trap for fever, but the remote cause assuredly exists in some of the volatile bodies in the atmosphere.—SMYTH'S *Mediterranean.*

HUNGER—THE CAUSE OF.

IN every living organism there is an incessant and reciprocal activity of *waste* and *repair*. The living fabric, in the very actions which constitute its life, is momently yielding up its particles to destruction, like the coal which is burned in the furnace: so much coal to so much heat, so much waste of tissue to so much vital activity. You cannot wink your eye, move your finger, or think a thought, but some minute particle of your substance must be sacrificed in doing so. Unless the coal which is burning be from time to time replaced, the fire soon smoulders, and finally goes out: unless the substance of your body, which is wasting, be from time to time furnished with fresh food, life flickers, and at length becomes extinct. Hunger is the instinct which teaches us to replenish the empty furnace.

But although the want of food, necessary to repair the waste of life, is the primary cause of hunger, it does not, as is often erroneously stated, in itself constitute hunger. The absence of necessary food causes the sensation, but it is not in itself the sensation. Food may be absent without any sensation such as we express by the word hunger being felt. Insane people frequently subject themselves to prolonged abstinence from food, without any hungry cravings; and, in a lesser degree, it is familiar to us all how any violent emotion of grief or joy will completely destroy, not only the sense of hunger, but the possibility of even swallowing the food which an hour before was cravingly desired. Further: it is known that the feeling of hunger may be allayed

by opium, tobacco, or even by inorganic substances introduced into the stomach, although none of these can supply the deficiency of food. Want of food is therefore the *primary*, but not the *proximate* cause of hunger.

We can now understand why hunger should recur periodically, and with a frequency in proportion to the demands of nutrition. Young animals demand food more frequently than the adult, birds and mammalia more frequently than reptiles and fishes. A lethargic boa-constrictor will only feed about once a month, a lively rabbit twenty times a day. Temperature has also its influence on the frequency of the recurrence: cold excites the appetite of warm-blooded animals, but diminishes that of the cold-blooded, the majority of which cease to take any food at the temperature of freezing. Those warm-blooded animals which present the curious phenomenon of "winter sleep," resemble the cold-blooded animals in this respect—during hibernation they need no food, because almost all the vital actions are suspended. It is found that at the temperature of freezing even digestion is suspended. Hunter fed lizards at the commencement of winter, and from time to time opened some of them, without perceiving any indications of digestion having gone on; and when spring returned, those lizards which were still living vomited the food which they had retained undigested in their stomachs during the whole winter.

Besides the usual conditions of recurring appetite, there are some unusual conditions, depending on peculiarities in the individual, or on certain states of the organism. Thus, during convalescence after some maladies, especially fevers, the appetite is almost incessant; and Admiral Byron relates that, after suffering from a month's starvation during a shipwreck, he and his companions, when on shore, were not content with gorging themselves while at table, but filled their pockets that they might eat during the intervals of meals. In certain diseases there is a craving for food which no supplies allay; but of this we need not speak here.

The animal body is often compared to a steam-engine, of

which the *food* is the *fuel* in the furnace, furnishing the motor power. As an illustration this may be acceptable enough, but, like many other illustrations, it is often accepted for a real analogy —a true expression of the facts. As an analogy, its failure is conspicuous. No engine burns its *own substance* as fuel: its motor power is all derived from the coke which is burning in the furnace, and is in direct proportion to the amount of coke consumed; when the coke is exhausted the engine stops. But every organism consumes its own body; it does not burn food, but tissue. The fervid wheels of life were made out of food, and in their action motor power is evolved. The difference between the organism and the mechanism is this,—the production of heat in the organism is not the *cause* of its activity, but the *result* of it; whereas in the mechanism, the activity originates in, and is sustained by, the heat. Remove the coals which generate the steam, and you immediately arrest the action of the mechanism; but long after all the food has disappeared and become transformed into the solids and liquids of the living fabric, the organism continues to manifest all the powers which it manifested before.

There is, of course, a limit to this continuance, inasmuch as vital activity is dependent on the destruction of tissue. The man who takes no food lives, like a spendthrift, on his capital, and cannot survive his capital. He is observed to get thin, pale, and feeble, because he is spending without replenishing his coffers; he is gradually *impoverishing* himself, because Life is waste.—Lewes: *Physiology of Common Life.*

THE WATER WE DRINK.

The water we drink is next in importance to the air we breathe. It forms three-fourths of the weight of living animals and plants; is the most abundant substance we meet with on the face of the Earth; and covers to an unknown depth at least three-fourths of its entire surface. That water is indispensable to animal and vegetable life, appears both from its forming so large a proportion of the bodies of living plants and animals, and from the amount,

visible and invisible, that is ever present in the atmosphere which both of them incessantly inhale. But many of the properties which water possesses are wonderfully conducive to our comfort, to the supply of our daily wants, and to the maintenance of the existing condition of things.

1. Thus, even the unheeded property of its freedom from smell and taste is important to animal comfort. Sweet odours are grateful to our nostrils at times, and pleasant savours give a relish to our rarer kinds of food; but health fails in an atmosphere which is ever loaded with incense and perfumes, or where the palate is daily pampered with high-seasoned dishes and constant sweets. The nerves of smell and taste do not bear patiently a constant irritation, and the whole body suffers when a single nerve is continually jarred. Hence it is that water and air, which have to enter so often into the animal body, and to penetrate to its most delicate and most sensitive organs and tissues, are made so destitute of sensible properties that they can come and go to any part of the frame without being perceived. Noiselessly, as it were, they glide over the most touchy nerves; and, so long as they are tolerably pure, they may make a thousand visits to the extremest parts of the body without producing the most momentary irritation or sense of pain. Externally, also, they can be applied to the most delicate, inflamed, or skinless parts of the body, not only without irritating, but generally with the most grateful and soothing effects. These negative properties, which are common both to air and water—though, as I have said, they are rarely thought of—are nevertheless most essential to our daily comfort.

2. Again: water possesses a cooling property, which is very grateful to all living things. The priceless value of water in "a dry and thirsty land" arises mainly from the necessity of constantly supplying that which, in a dry and warm atmosphere, is constantly evaporating from the skin and the lungs. But in all climates water has a cooling power, which gives it a new value to the hot and fevered animal. When taken into the mouth and stomach, or when poured over the inflamed skin, it cools more

than an equal weight of any other liquid or solid substance we could apply. This arises from the circumstance that it takes more heat to give a sensible warmth to water than to an equal weight of any other common substance. Thus, the same quantity of heat which is required to raise the temperature of 1℔ of water a single degree (from 60° to 61°, for example), would give an equal increase of temperature to 30℔ of quicksilver; and so, again, to convert water into vapour requires more heat than an equal weight of any other liquid we consume. Hence when water evaporates from the skin it serves as a constant cooler of the surface; while the vapour which escapes with the breath cools equally the interior of the body. It is really very interesting to observe how the great capacity of liquid water for heat makes it so gratefully cooling as it enters the body; and how its still greater capacity for heat when passing from the liquid state to the state of steam enables it so constantly to bear away from us the germs of fever, as it escapes from our bodies in the form of insensible vapour.

3. But the peculiar composition of water is also a very important circumstance to animal and vegetable life. It consists of oxygen and hydrogen; and all the solid parts of animals and plants contain these same elements in large proportion. In the dry wood of the tree, for example, and in the dry flesh and bone of the animal, both are present. Now, as the plant and animal increase in size, oxygen and hydrogen are required for the formation of their growing parts, and water is everywhere at hand to supply these necessary ingredients. This is a chemical duty which no other liquid but water could so well perform. Water, in discharging this duty, is not merely the drink, as we usually call it, but is really part of the food both of animal and plant.

4. Further: pure water has the property of mixing with some other fluids in all proportions, merely weakening or diluting their strength. With others, again—as with oil—it refuses to mingle. Solid substances it has the property of dissolving; and upon this property depend many of the most useful purposes served by

water, in reference both to animal and vegetable life.—*Abridged from* JOHNSTON'S *Chemistry of Common Life.*

THIRST—THE CAUSE OF.

As deficiency of food to supply the waste of tissue is the primary cause of hunger, so deficiency of water to supply the waste which goes on incessantly in the excretions—respiration and perspiration—is the primary cause of thirst. Every time we breathe we throw from our lungs a quantity of water in the form of vapour. We are made sensible of this when the breath condenses on the colder surface of glass or steel; and when, as in winter, the atmosphere s sufficiently cold to condense the vapour on its issuing from our nouths. This is only one source of the waste of water: a more mportant source is that of perspiration, which in hot weather, r during violent exercise, causes the water to roll down our skins rith obtrusive copiousness. But even when we are perfectly uiescent, the loss of water, although not obvious, is considerble.

It is calculated that there are no fewer than twenty-eight miles f minute ducts or capillary tubing on the surface of the human ody, from which the water escapes as *insensible perspiration;* nd although the amount of water which is thus evaporated from he surface must necessarily vary with the clothing, the activity, nd even the peculiar constitution of the individual, an average stimate has been attained which shows that from *two to three ounds of water* are daily evaporated from the skin. From the ings it is ascertained that every minute we throw off from four o seven grains of water; from the skin eleven grains. To these nust be added the quantity attracted by the kidneys, a variable ut important element in the sum.

It may not at first sight be clear why an abstraction of water aily should profoundly affect the organism unless an equivalent e restored. What can it matter that the body should lose a ttle water as vapour? Is water an essential part of the body?

Is it indispensable to life? Not only is water an essential part of the body, it might be called the *most* essential, if pre-eminence could be given where all are indispensable. In quantity, water has an enormous preponderance over all other constituents: it forms 70 per cent. of the whole weight! There is not a single tissue in the body—not even that of bone, not even the enamel of the teeth—into the composition of which water does not enter as a necessary ingredient. In the nervous tissue 800 parts out of every 1000 are water; in the lungs, 830; in the pancreas, 871; in the retina, no less than 927.

Commensurate with this anatomical preponderance is the physical importance of water. It is the carrier of the food, the vehicle of waste. It holds gases in solution, dissolves solids, helps to give every tissue its physical character, and is the indispensable condition of that ceaseless change of composition and decomposition on which the continuance of life depends. From the elaborate experiments of Bidder and Schmidt, it is clear that the changes which go on in the organism are far more concerned with its water than with its solids. In the digestive fluids, for example, from one-fifth to one-fourth of the water contained in the body will be found passing and re-passing; whereas only one-sixtieth or one-seventieth of the solids of the body pass into them.

Such being the part played by water in the organism, we can understand how the oscillations of so important a fluid must necessarily bring with them oscillations in our feelings of comfort and discomfort, and how any unusual abstraction of it must produce that disturbance of the general system known under the name of "raging thirst"—a disturbance far more terrible than that of starvation, and for this reason: during abstinence from food the organism can still live upon its own substance, which furnishes all the necessary material; but during abstinence from liquid, the organism has no such supply within itself. Men have been known to endure absolute privation of food for some weeks; but three days of absolute privation of drink, unless in a moist atmosphere, is perhaps the limit of endurance.—LEWES: *Physiology of Common Life.*

THE PHILOSOPHY OF RECREATION.

OFF FOR THE HOLIDAYS.

The philosophy of holidays is the philosophy of recreation. But the whole subject of recreation is only now beginning to be understood. We do not proscribe amusements, as some generations have done; nor do we go heartily into them, as paganism did and the Latin races do; but we indulge in them, and apologize for them. We take some of our most pleasant and most needful recreations with a half suspicion that they are only half right. There is, consequently, an entire want of abandon in them, for which some of us make up by an extreme abandon when we are off for the holidays. We are dreadfully afraid of making ourselves ridiculous before one another, but we take it out with interest by making ourselves extremely ridiculous in the eyes of foreigners. But nothing shows the popular misunderstanding on the whole subject of recreation so thoroughly as this fear of being ridiculous. Public opinion often exhibits the extremest ignorance of human nature, but in nothing is it more entirely childish than in its ideas on amusement and recreation. It persistently merges the man in his profession, keeps him perpetually on the pedestal of his status, and will on no account allow him to descend from it. It judges the fitness of his amusements by the nature of his duties; expects everlasting gravity from those whose calling is a grave one, and perpetual lightheartedness from those whose vocation is to amuse. Yet a moment's thought would show to the least penetrating of persons that no true recreation can be found in the line of a man's calling. It is that disgust of sameness which makes us need change of scene, and drives us off for the holidays, which justifies and necessitates recreation of every kind. Change is the first condition of relaxation. A man might just as well sleep in his full evening dress as seek his amusement in the same direction as his work. Work and play, like day and night, are opposites,

and the widest unlikeness between them is the truest completeness of each. Of course there must be no moral incongruity between any part of a true man's life, but physically and intellectually there cannot be too wide a difference between his labour and his recreation. They should surround him with different associations, call up different feelings, exercise different faculties, appeal to different parts of his nature; should be, in fact, the antithesis of each other. The man of sedentary occupation should take active recreation; the man of laborious work needs restful play. The student requires unintellectual amusement; the tradesman may find his recreation in books. The man whose calling needs the preservation of an official dignity, requires as recreation something in which even personal dignity may be laid aside and forgotten—some innocent but not dignified amusement in which he descends to the level of others, and is no longer the priest or the pedagogue, the justice or the physician, but simply the man.

This seems to be the "rationale" of recreation. Recreation is something more than amusement; for amusement merely occupies or diverts, while recreation, as the word itself indicates, renews and recreates. But this renewal and recreation proceeds on the principle of antithesis. Life is a balance of opposites, health is their equipoise, and the overbalancing of either is disease and death. Arctic explorers tell of the dreadful persecution of perpetual daylight in the six months' polar day, and of the terrible depression produced by the perpetual darkness in the six months' night. But the beautiful alternation of these opposites in the habitable parts of the globe, the perpetual swing of this exquisitely-balanced antithesis, is the fundamental condition of our healthy activity. Nature does not leave us to balance work and rest, but does all she can to strike a balance for us. Yet even the rest of sleep is something more than the cessation of activity. Every muscle in the body has its correlative, and it is by the use of the one that the other is rested. All muscular action consists of contractile movement, and a muscle can only be elongated by the pull caused by the contraction of its correlative. We rest by employing other muscles than those on which the stress of action

has lain. When I close my eyes from very weariness, the muscles which have kept them open lose their contractility, the opposite muscles come into play, and by contraction pull down my eyelids and elongate the muscles, which in their turn will contract to-morrow, and open my eyes to the daylight. This principle of rest by alternation of activity runs through the greater part of our experience. Play is change of work; not change which merely gives the same organs or faculties something else to do, but change which brings other and correlative organs or opposite faculties into action. Mere rest is not true recreation. An unused power or faculty will not fitly counterbalance an overworked one. To keep one eye shut would never compensate for overuse of the other; yet it is just that overuse of some one power or faculty which is the evil we all need to redress. We are created men, and it is only by art that we are made into tradesmen or statesmen, literary men or handicraftsmen, professional men or workmen. Our vocation is a limitation put upon us by necessity—a narrowing of our life into a special channel—a straitening of our energies into one line of special faculty; and its unavoidable result is, a one-sided development of our powers. But in its highest and truest form recreation is the prevention of this one-sidedness. A really noble recreation is a perfecting discipline. It redresses the injured balance of our nature; cultivating that side of it which our vocation neglects; developing those powers our necessary business depresses; and out of the man of study or of business, out of the statesman or the tradesman, reproducing and recreating the man.

Many examples might be given in illustration of the principle here stated. When the instinctive action of mind or body suggests a restorative or recreative movement, it will usually be found to proceed on this principle of complement, compensation, or antithesis. It is a well-known optical experience, that when an eye which has been dazzled by some brilliant colour is turned away from it to some colourless object, that object is partially obliterated by a patch or blot of some other quite different colour. But the imaginary colour bears an exact relation to the colour

which produced the dazzling effect. It is its correlative, its complement, its opposite; and the mingling of the two would produce perfect harmony, because they would constitute perfect light. But this physical fact has a hundred parallels in our moral and intellectual life. Our castles in the air are never counterparts of home; they are generally complementary to it. The ideal life we picture to ourselves in day-dreams is generally set in vivid contrast to the life we really live. Escaping into a world we can create after our own fancy, it is often the antithesis of this. But this escape from the real into the ideal would not be possible to any were not our nature "antithetically mixed." Physically and mentally, over-balance is distress and disease, equipoise is happiness and health; and whether it be needful duties or unavoidable experience, cherished habits or detested necessities, which throw the weight on one side, that only is a truly restorative discipline or recreative experience which puts an equal weight upon the other side.

Guided by this principle, it would be very possible for us to select our recreations with a near approach to scientific fitness. To understand the nature of recreation, and the high purposes it may subserve, is to be far on the road to the discovery of its method. Physically, it should be directed to the restoration of the body's wholeness, by insuring the equal and harmonious development of all its parts. Intellectually, it should aim at rounding off our experience, and extending the culture of our faculties to every part of them. It should not minister to the mere love of change or the desire of novelty, though new experiences and changed surroundings are essential to its perfectness. It should be change of occupation and of mental air. It should take us into a new world, and open a wider horizon to our observation and experience. Holiday travel is, in fact, its typical form; and that recreation will be most truly recreative to which we can turn from time to time with all the zest of freshness, in which we can forget our cares and merge our anxieties, and which is so far from the track of necessary work, so different from our enforced activity, that we can enter on it with something of that fresh and

joyous feeling with which at this moment we are "off for the holidays."—*Abridged from the Cornhill Magazine.*

INFLUENCE OF DEPTH ON PLANTS AND ANIMALS IN THE EUROPEAN SEAS.

THE influence of depth is everywhere manifest in the European seas; for everywhere we find creatures, whether animal or vegetable, distributed in successive belts, from the margin of the high-water mark down to the deepest abysses from which living beings have been extracted. Peculiar types inhabit each of the zones in depth, and are confined to their destined regions, whilst others are common to two or more zones; and not a few appear to have the hardiness to brave all bathymetrical* conditions. Nevertheless, so marked is the *facies* (aspect or appearance) of the inhabitants of any given region of depth, that the sight of a sufficient assemblage of them from some one locality can enable the naturalist to speak at once to the soundings within certain limits, and without the aid of line or plummet. Throughout the oceanic portion of the seas of Europe, four distinct and well-marked zones of life succeed each other.

The first of these is the *Littoral Zone* (Lat. *litus*, *littoris*, the sea-shore), equivalent to the tract between tide-marks, but quite as manifest in those portions of the coast-line where the tides have a fall of a foot or two, or even less, as in districts where the fall is very great. This important belt, which is inhabited by animals and plants capable of enduring periodical exposure to the air, to the glare of light, the heat of the sun, the pelting of rain, and often to being less or more flooded with fresh water, when the tide has receded, claims many genera as well as species peculiar to itself. These, again, are not distributed at random within the littoral space, but are arranged in sub-zones which may be

* Bathymetrical (Gr. *bathys*, depth; and *metron*, measure) and hypsometrical (Gr. *hypsos*, height; and *metron*) are opposite terms; the former referring to zones or belts of depth, the latter to zones of altitude.

traced on rocky shores when the tide is out, even by the most inexperienced eyes, forming variously-coloured belts, banding the base of the land.

Succeeding this great shore-band we have the region of sea-weeds—the *Laminarian Zone* (Lat. *Laminaria*, the broad-leaved sea-tangle). It extends from the edge of low-water to a depth varying in different localities, but seldom exceeding fifteen fathoms. The laminarian zone is itself divided into sub-regions, marked by belts of differently tinted algæ (Lat. sea-weeds). It claims a numerous population of animals peculiar to itself, and is the chosen residence of fishes, molluscs, crustaceans, and invertebrata of all classes, remarkable for the brightness and the variegation of the patterns of their colouring. This region, above all others, swarms with life; and when we look down through the clear waters into the waving forests of broad-leaved tangles, we see animals of every possible tint sporting among their foliage, darting from frond to frond, prowling among their gnarled roots, or crawling with slimy trail along their polished, bronzy expansions.

To the laminarian succeeds the *Coralline Zone*, wherein the horny plant-like structures of zoophytes delight to rear their graceful feathery branches, whose flowers are animals rivalling plants in symmetry and beauty. This region has a wide extension, well on to some thirty fathoms or more in most places, commencing at the termination of the zone of sea-weeds, especially that portion of the latter where the coral-like nullipores (vegetables simulating minerals in colour and consistence) abound, and furnish a ground well fitted for the spawning of fishes. Here we have great assemblages of marine animals, both vertebrate and invertebrate, but plants are few and far between.

Last and lowest of our regions of submarine existence is that of *Deep-sea Corals*—so named on account of the great stony zoophytes characteristic of it in the oceanic seas of Europe. In its depths the number of peculiar creatures is small, yet sufficient to give a marked character to it; whilst the other members of its population are derived from the higher zones, and must be re-

garded as colonists. As we descend deeper and deeper in this region its inhabitants become more and more modified, and fewer and fewer, indicating our approach towards an abyss where life is either extinguished or exhibits but a few sparks to mark its lingering presence. Its confines are yet undetermined, and it is in the exploration of this vast deep-sea region that the finest field for submarine discovery yet remains.

Such is the general subdivision of the sea-bed as exhibited in the European seas. In the Mediterranean, however, as might be expected, when we consider the peculiar conditions under which that great land-locked basin is placed, there are peculiarities in the distribution of both animal and vegetable life which require special consideration.—EDWARD FORBES: *Natural History of the European Seas.*

EARTH-EATERS AND EDIBLE EARTHS.

IT is currently reported throughout the coasts of Cumana, New Barcelona, and Caracas (which the Franciscan monks of Guiana are in the habit of visiting on their return from the missions), that there are men living on the banks of the Orinoco who eat earth. On the 6th of June 1800, on our return from the Rio Negro, when we descended the Orinoco in thirty-six days, we spent the day at the mission inhabited by these people (the Otomacs). Their little village, which is called La Concepcion dé Uruana, is very picturesquely built against a granite rock. It is situated in 7° 8′ 3″ north latitude; and, according to my chronometrical determination, in 67° 18′ west longitude. The earth which the Otomacs eat is an unctuous, almost tasteless clay, true potter's earth, of a yellowish-gray colour, in consequence of a slight admixture of oxide of iron. They select it with great care, and seek it in certain banks on the shores of the Orinoco and Meta. They distinguish the flavour of one kind of earth from that of another; all kinds of clay not being alike acceptable to their palate. They knead this earth into balls measuring from four to six inches in diameter, and bake them before a slow fire,

until the outer surface assumes a reddish colour. Before they are eaten the balls are again moistened. These Indians are mostly wild, uncivilized men, who abhor all tillage. There is a proverb current among the most distant of the tribes living on the Orinoco, when they wish to speak of anything very unclean—"So dirty that the Otomacs eat it."

As long as the waters of the Orinoco and the Meta are low, these people live on fish and turtles. They kill the former with arrows, shooting the fish as they rise to the surface of the water with a skill and dexterity that has frequently excited my admiration. At the periodical swelling of the rivers the fishing is stopped, for it is as difficult to fish in deep river water as in the deep sea. It is during these intervals, which last from two to three months, that the Otomacs are observed to devour an enormous quantity of earth. We found in their huts considerable stores of these clay balls piled up in pyramidal heaps. An Indian will consume from three-quarters of a pound to a pound and a quarter of this food daily, as we were assured by the intelligent monk Fray Ramon Bueno, a native of Madrid, who had lived among these Indians for a period of twelve years. According to the testimony of the Otomacs themselves, this earth constitutes their main support during the rainy season. In addition, they however eat, when they can procure them, lizards, several species of small fish, and the roots of a fern. But they are so partial to clay that even in the dry season, when there is an abundance of fish, they still partake of some of their earth-balls, by way of a *bonne bouche* after their regular meals.

These people are of a dark, copper-brown colour, have unpleasant Tartar-like features, and are stout, but not protuberant. The Franciscan, who had lived amongst them as a missionary, assured us that he had observed no difference in the condition and well-being of the Otomacs during the periods in which they lived on earth. The simple facts are therefore as follows: The Indians undoubtedly consume large quantities of clay without injuring their health; they regard this earth as a nutritious article of food—that is to say, they feel that it will satisfy their hunger

for a long time. This property they ascribe exclusively to the clay, and not to any other articles of food which they contrive to procure from time to time in addition to it. If an Otomac be asked what are his winter provisions—the term winter in the torrid parts of South America implying the rainy season—he will point to the heaps of clay in his hut. These simple facts do not, however, by any means decide the questions: Whether clay can actually be a nutritious substance? Whether earths can be assimilated in the human body? Whether they only serve as ballast, or merely distend the walls of the stomach, and thus appease the cravings of hunger? These are questions which I cannot venture to decide. It is singular that Father Gumilla, who is generally so credulous and uncritical, should have denied the fact of earth being eaten by and for itself. He maintains that the clay balls are largely mixed with maize-flour and crocodile's fat. But the missionary Fray Ramon Bueno, and our friend and fellow-traveller the lay-brother Fray Juan Gonzales, who perished at sea off the coast of Africa (at the time we lost a portion of our collections), both assured us that the Otomacs never mix their clay cakes with crocodile's fat, and we heard nothing in Uruana of the admixture of flour.

The earth which we brought with us, and which was chemically investigated by M. Vauquelin, is quite pure and unmixed. May not Gumilla, by confounding heterogeneous facts, have intended to allude to a preparation of bread from the long pod of a species of Inga, as this fruit is certainly buried in the earth, in order to hasten its decomposition? It appears to me especially remarkable that the Otomacs should not lose their health by eating so much earth. Has this tribe been habituated for generations to this stimulus?

In all tropical countries men exhibit a wonderful and almost irresistible desire to devour earth, not the so-called alkaline or calcareous earth, for the purpose of neutralizing acidity, but unctuous, strong-smelling clay. It is often found necessary to shut children up in order to prevent their running into the open air to devour earth after recent rain. The Indian women who

are engaged on the river Magdalena, in the small village of Banco, in turning earthenware pots, continually fill their mouths with large pieces of clay, as I have frequently observed, much to my surprise. Wolves eat earth, especially clay, during winter. It would be very important, in a physiological point of view, to examine the excrements of animals that eat earth. Individuals of all other tribes, excepting the Otomacs, lose their health if they yield to this singular propensity for eating clay. In the mission of San Borja we found the child of an Indian woman, which, according to the statement of its mother, would hardly eat anything but earth. It was, however, much emaciated, and looked like a mere skeleton.

Why is it that in the temperate and cold zones this morbid eagerness for eating earth is so much less frequently manifested, and is, indeed, limited almost entirely to children, whilst it would appear to be indigenous to the tropical lands of every quarter of the earth? In Guinea the negroes eat a yellowish earth, which they call *caouac;* and when they are carried as slaves to the West Indies they even endeavour there to procure for themselves some similar species of food, maintaining that the eating of earth is perfectly harmless in their African home. The caouac of the American islands, however, deranges the health of the slaves who partake of it; for which reason the eating of earth was long since forbidden in the West Indies: notwithstanding which a species of red or yellowish tuff (*un tuf rouge jaunâtre*) was secretly sold in the public market of Martinique in the year 1751.

"The negroes of Guinea," according to Thibault de Chanvalon, "say that in their own country they *habitually* eat a certain earth, the flavour of which is most agreeable to them, and which does not occasion them any inconvenience. Those who have addicted themselves to the excessive use of caouac are so partial to it, that no punishment can prevent them from devouring this earth." In Borneo, and in Java near Samarang, Labillardière saw small square reddish cakes publicly sold in the villages. The natives called them *tana ampo* (*tanah* signifies "earth" in

Malay and Javanese); and on examining them more closely, he found that they were cakes made of a reddish clay, and intended for eating. The edible clay of Samarang has recently (1847) been sent, by Mohnike, to Berlin in the shape of rolled tubes like cinnamon, and has been examined by Ehrenberg. It is a fresh-water formation deposited in tertiary limestone, and composed of microscopic *Polygastrica* (*Gallionella*, *Navicula*) and of *Phytolitharia*. The natives of New Caledonia, to appease their hunger, eat lumps as large as the fist of friable steatite, in which Vauquelin detected an appreciable quantity of copper. In Popayan and many parts of Peru calcareous earth is sold in the streets as an article of food for the Indians. This is eaten together with the coca (the leaves of the *Erythroxylon Peruvianum*). We thus find that the practice of eating earth is common throughout the whole of the torrid zone, among the indolent races who inhabit the most beautiful and fruitful regions of the Earth.

But accounts have also come from the north, through Berzelius and Retzius, from which we learn that in the most remote parts of Sweden hundreds of cart-loads of earth containing infusoria, or microscopic animalcules, are annually consumed by the country people as bread-meal, more from fancy than from necessity. In some parts of Finland a similar kind of earth is mixed with the bread. It consists of empty shells of animalcules, so small and soft that they break between the teeth without any perceptible noise, filling the stomach without yielding any actual nourishment. Chronicles and archives often make mention during times of war of the employment as food of infusorial earth, which is spoken of under the indefinite and general term of "mountain meal." Such, for instance, was the case in the Thirty Years' War, at Camin in Pomerania, Muskau in the Lausitz, and Kleiken in the Dessau territory; and subsequently in 1719 and 1733 at the fortress of Wittenberg.—HUMBOLDT: *Views of Nature*.

EXTRACT OF MEAT, AND ITS VALUE.

From a certain quantity of fresh beef every particle of fat, bone, and tendon is carefully removed. It is then chopped up and placed in a vessel, with a small quantity of water, in a water-bath, great care being taken to remove the albuminous coagulation which forms, as well as any fatty matter which may show itself. After a time a pale-brown, thickish fluid, of the consistency of treacle, will be found in the vessel. This is pure meat-juice; the sap, so to say, of the flesh. It is then poured off, leaving behind all the fibrous remains. As a proof how entirely every nourishing particle is extracted from the beef by this process, no animal will eat the residue; and if a dog be forced by hunger to feed upon it, he will starve.

One pound, then, of this preparation contains the essence of thirty-two pounds of beef. From a smaller quantity of meat this amount of essence is not to be obtained; and whoever professes to do so *must* have with his extract something more than the pure juice. Unless *quite pure*, it is liable to spoil.

A remarkable circumstance is, that this extract of meat, unlike meat itself, will keep for years without undergoing any change. I have seen two potsful ten years old, which were as good and fresh as though of yesterday, and they had only been covered with a piece of writing-paper in the same way as is done with a jar of preserves. From the following circumstance, indeed, it would almost seem as if the extract possessed an anti-corrupting power. The two pots of ten years ago had been kept in a cellar where, owing to the damp of the place, a furry mould had formed about them, and even on the edges inside; but wherever the slightest particle of this essence had touched the earthenware pot, there was no trace of mouldiness. Here, then, we have an essential requisite—the certainty of the preparation not changing or becoming unfit for use. Nor is any peculiar care or mode of storing necessary in order to insure this. Whether in dry or damp places, it remains the same. One quarter of a teaspoonful of the juice that for ten years had been

loosely covered with but a sheet of paper, tasted, when mixed with hot water and a little salt, like delicious beef-tea made that same morning. Another equally essential quality is its compendiosity. In a tin case 10lb weight, the essence of 320lb of meat is contained.

It may be thought that the gelatine tablets, which when dissolved in water form a sort of broth, are in reality the same as the meat-essence here spoken of. But this would be a totally false supposition. The tablets are made from the tendons and muscular fibre, and contain much glue—gelatine—without any nourishment whatever. After a time, a sick person fed on such preparation gets disgusted; as was the case with the patients in the Hotel de Dieu at Paris.

Now, the use of pure meat-juice has just the contrary result. It is not only so agreeable to the taste that persons who have taken it in their invalid state continue to do so after perfect recovery, but it appears to have a wonderfully restorative influence, by assisting the digestive organs in their functions, instead of oppressing or weakening them. It seems to act in the same way as the gastric juice—to help to digest food and cause its assimilation with the body. Indeed, a French physician found the residue of gastric juice to be very analogous to pure essence of meat. He further tried to discover the cause of this power to further the assimilation of food; but as there is a boundary beyond which it is vain for human investigation to go, his efforts led to nothing. We know, for example, how meat may be produced, and the various forms in which it is present; but as to its innermost nature, how it is that what is hot imparts warmth, that is a secret which no analysis will explain or enable us to understand. It is not at all improbable that the similarity between meat-essence and its effects, and gastric juice and its functions, should produce that exhilarating restorative influence which the former invariably effects on the exhausted and suffering. The essence contains, too, phosphate in large quantities, and the same lactic acid which is secreted by the muscles in all bodily exertion.

The beneficent uses to which this meat-essence may be applied are manifest. For the sick, as has already been stated, it is an especial Godsend. Even in cases of gastric fever, when, from the nature of the disease, the stomach is peculiarly unfitted to support food, to digest and assimilate, this pure juice is found grateful, exhilarating, and strength-giving. To the weak stomach it seems rather like a congenial essence akin to its own nature, than a foreign element or an extraneous thing; a circumstance which might be thought to prove the truth of the French chemist's assertion more strongly even than his analysis.

The use of this meat-essence in the military hospital at Munich has brought to light a fact important to the physician. It has been found that the convalescence of patients who have been suffering from typhus is accelerated in a wonderful degree by the introduction of this meat-juice as an article of their diet: so that, dear as it is, calculation has proved its use in such cases would be profitable, if on economic grounds only; so quickly do the men recover their strength and become fit for duty.

On the battle-field this extract, so portable and so easily made into warm bouillon, would be a boon indeed. We all remember how highly the refreshing cup of tea was prized which, by Miss Nightingale's thoughtfulness, was given to the wounded men in the Crimea as they were borne away from the battle-field. A draught of the refreshing beverage upheld the fainting strength of many a poor fellow who, but for that kindly help, would have sunk long before he reached the hospital. A fire and an iron kettle and some salt are always to be had; and these, with a tin case of the precious meat-juice, are sufficient to support the failing life of men who are battling with their agony.

In a case of violent hæmorrhage, followed by extreme exhaustion, it was given with all possible success. At first two cups of weak bouillon were taken daily, then some a little stronger—one-eighth of an ounce of extract to one pound of water—and for fourteen days this was the sole nourishment. Though gastric fever had supervened, the patient recovered strength, and

in six weeks was able to walk a little. The veins under the eyes, which had been quite emptied by the excessive loss of blood, recovered their former state, and a healthy hue took the place of the former livid pallor.

How invaluable, too, for the sick on ship-board, whose recovery fresh meat would so greatly further! But to the sailor as yet strong and well it would also prove a preservative against illness; for it has been discovered that it is not salt which is the cause of scurvy, so prevalent during long voyages, but the absence of a great portion of the assimilating particles of the meat, two-thirds of which are lost in the brine. It is the want of creatine and creatinine, and phosphate of potash, and lactic acid—of that, in short, which may be called food for the nerves—which produces scurvy in men who feed on salt meat for any length of time. Supply such meat with some of its removed juice, and it ceases to render scorbutic. Even old junk may still be given to a crew, and would prove nourishing and wholesome, if to half a pound of meat per man one-eighth of an ounce of the meat-juice were added, either as sauce or mixed with vegetables. The pristine nourishing quality of the beef is thus restored to it. But as on board ship there is always a store of pease, beans, and other pulse, these might simply be boiled, and a small quantity of the meat-essence added to them. This would form a change of diet, and be both palatable and nourishing.

The adoption of the essence in hospitals, even in time of peace, would have this advantage, that the patients for whom it was prescribed would get what was intended for them. At present, in many instances, the good strong soup is appropriated by the attendants, while the weaker decoction only reaches the invalid. Even where epidemics rage from insufficiency of nourishment, or from unwholesome food, this extract will serve to alleviate the misery; for, if not within the reach of the wholly destitute, its cheapness will always enable the charitable, as well as the Government, to do an immense amount of good with sums comparatively small.—*Abridged:* C. Boner, *in Popular Science Review.*

THE SKIN: ITS STRUCTURE AND FUNCTIONS.

It is a characteristic difference between the works of man and the works of the Creator that the former has to adopt many contrivances, and employ a cumbrous machinery to bring about a single result, whereas the Creator generally accomplishes several ends by one and the same agent; and in few organs of the body, or in none, perhaps, is this more manifest than in the Skin. Most people would, perhaps, be startled to hear that our stomach, our liver, nay, even our brain itself, is less necessary to life than our skin. Yet it is well known that we may do without food—live without calling our stomach into action—for several days; that the liver also may wholly cease to act for several days before death ensues; and it has also been known that monsters have been born without any brain whatever, and yet have survived for several days, discharging all the functions of organic life—exercising motion, sucking at the breast like other infants, digesting their food, &c.—and have continued so to do for a number of days greater than the number of hours it would be possible to survive were the functions of the skin completely stopped. The experiment has actually been made on the lower animals, and the results show that the skin is a most important auxiliary to the lungs in the process of aëration of the blood; and that, if its functions be arrested—as has been done by varnishing the fur of a rabbit, and gilding the skin of a pig—the unfortunate animal dies in a couple of hours or so, with all the symptoms that would be produced by a slow cutting off of the supply of air to the lungs.

From these experiments we can easily infer how important a matter it must be to keep this organ constantly in an efficient state (by washing and bathing) for the discharge of this as well as of its other important functions. Indeed, this one organ the Creator has put specially into our charge and within our reach, while all the other vital organs are beyond our control. Yet often, when we have neglected the charge, and suffer in consequence, we lay the blame upon organs wholly guiltless of our

sufferings, such as the liver and stomach, which will work perfectly right without our care or attention, if we only give them fair play, and do not, by our neglect of the skin, throw upon them an amount of work twice as great as their proper share.

Aëration of the blood is not, however, the only function which the skin has to discharge; absorption is another, though not of equal importance. This is carried on by a system of vessels called the lymphatic vessels, which permeate the skin everywhere over the whole surface of the body. To illustrate this function we may mention the fact, that persons in whom disease has closed up the natural entrance to the stomach by the throat, have been kept alive for days and weeks by being frequently immersed in a warm bath of milk. The late celebrated Duc de Pasquier, who died at the age of ninety, had been kept alive for some weeks before his death by this means. Various salts also have been detected in the secretions of persons who have used baths containing those salts in solution, such salts having been taken up by the skin. Persons in distress for want of water at sea have also sometimes relieved their thirst by bathing the body in sea-water, so rapidly is absorption carried on under such circumstances.

Another and a most important function of the skin is that of the special sense of touch, which is only a highly exalted form of general sensation that resides specially in this organ, and depends on its healthy state for its delicacy and accuracy of manifestation. The functions of the skin as a covering for the body, adding beauty and preserving the delicate structure underneath, regulating the intensity of sensations from without and the amount of temperature within, are a further illustration of the multiplicity of ends attained by the Creator through one and the same agency. And, though last, not least, we may mention the function of secretion, or removing from the body materials no longer of use to it, and which, if retained, would become actually injurious.

The skin, which discharges these numerous and important offices, is composed of two layers ;—an outer, called the *cuticle*, *epidermis*, or *scarf-skin ;* and an inner, called the *cutis*, *dermis*, or *true skin.* This latter rests upon a very fine interlaced or

netted structure called the *areolar tissue;* out of which, if we may so express it, the granules and fibres of the skin are formed. It has been usual to describe a third layer, placed between the true skin and the scarf-skin, and called the *rete mucosum,* or pigment layer; but later researches have shown that there is no such distinct layer, and that the pigment cells, to which the colour of the skin in different races is due, are but a different stage in the development of the scarf-skin.

The cuticle or scarf-skin is in general very thin, and consists of several layers of laminated scales, the laminated form being best marked at the very surface, where the scales are constantly falling off as a kind of scurf, and are as constantly being renewed from below. Into the epidermis or cuticle no nerves or blood vessels penetrate, and it is nourished merely by the transudation of the serum, or watery portion of the blood, through the walls of the vessels of the true skin and subcutaneous areolar tissue. As it has no nerves, it is not itself sensitive, but, on the contrary, serves to blunt the too exquisite sensation of the true skin. That it has no sensibility of its own may be proved when a small portion of it is detached from the underlying surface of the true skin, as by a blister; and this is the best way of demonstrating the cuticle in a living person, as it is extremely difficult to detach any portion of it by mechanical means. The scarf-skin in man corresponds to the scales in fishes and scutes in reptiles; and the nails of the toes and fingers are merely the cuticle modified for special and local purposes.

The cutis or true skin, which is much more highly organized, consists of two kinds of tissue—namely, white and yellow fibres; the former being denser and more resisting, and being therefore present in greater quantity wherever resistance is most needed, as in the palm of the hand and sole of the foot; while the yellow fibres are a highly elastic tissue, and exist in greater abundance where elasticity is a special requirement, as at the flexures of the joints, the lips, &c. The upper surface of the true skin is strangely uneven and irregular, being elevated into a vast number of minute papillæ, which are about 1-100th of an inch in length

and 1-250th of an inch in diameter: Minute as these papillæ are, each possesses a ramification of vascular capillaries and of nerve fibres; the latter, though not traceable to the very surface, being, in fact, the essential agents in the sense of touch, for that is the function of these papillæ—they are the seat of the tactile power, and accordingly we find them developed in the greatest number and perfection where the tactile power is highest, as along the tips of the fingers and the lips. The number of these papillæ is immense; a square inch of the palm of the hand contains more than forty rows, and each row more than sixty pairs, making in all about five thousand papillæ in a single square inch of skin. They are not, however, equally developed in all parts of the body, being nearly absent in the back, where the cutis is tolerably dense, for there is no relation between its thickness and the development of these papillæ. On the tongue, for instance, the cutis is extremely thin, and yet the papillæ there are longer than in any other part of the body; and not that alone, but so thin also is the cuticle here that the individual papillæ are seen, giving that peculiar roughness to the tongue which is found to a certain degree in man, and to a very high degree in some of the lower animals, as the ox and cat tribes.

We come now to the function of secretion, and the description of the beautiful and complex apparatus by which that function is carried on. When we look with a simple lens, or even with the naked eye, at the delicate grooves crossing the furrows of the hands, we find that a small orifice exists in the centre of each of them, sometimes occupying nearly the whole of the groove. This is, in fact, the orifice of a perspiratory duct; and when the hand is warm, the perspiration may be observed, even with the naked eye, to issue from it, forming minute shining dots. The glands by which the perspiration is secreted are seated at the under surface of the true skin, each embedded in a cavity in it; and they consist, like many other glands, of a ravelled tube, formed of basement, membrane, and epithelial scales, together with the secreting structure, the materials for secretion being furnished by a minute capillary net-work of blood-vessels arising

from arterial trunks, which bring the blood to the gland to be purified, and terminating in venous trunks, which carry off the blood when that process is performed. These glands are consequently to be regarded as true secretory organs, removing from the blood materials that are no longer wanted, and which, if retained, would be injurious. Their size varies in different situations, being in the palm of the hand from 1-100th to 1-200th of an inch in diameter, but in the arm-pits, where they form a very thick layer, they reach the size of 1-60th of an inch.

It was to this glandular system we referred when we said there was a beautiful contrivance for regulating the internal temperature of the body; for the perspiration so poured out is vaporized principally by the heat of the body, and in thus turning into vapour, it renders latent, as all liquids do in undergoing that change, an enormous amount of heat, which is thus being constantly carried away from the body as fast as it is generated by the chemical processes constantly going on within the system. Hence we see the cause of that burning heat of skin which is so marked a symptom of some diseases when the perspiration is completely arrested, causing that peculiar, harsh, dry skin, which is so well known to the physician as the concomitant of this burning heat. It is due to the same cause that the blood never exceeds about 98° Fahr. in temperature, even under violent exercise; for a copious flow of perspiration carries off the heat so generated. And for the same reason it is possible in dry air to bear with impunity a degree of heat much beyond what could be borne in moist air, where the perspiration would not be vaporized as fast as excreted. The amount of liquid which issues from the pores of a person in health during the twenty-four hours is not less than an imperial pint, containing about an ounce of solid matter in solution, besides a large amount of carbonic acid gas; hence we can estimate the importance of keeping those ducts in perfect order by means of frequent bathing and friction.

Another kind of gland is also found in the skin, in connection with the hairs and engaged in their nutrition. These glands, several of which are connected with each hair, are called the

sebaceous glands, inasmuch as they furnish an oily or waxy substance to nourish the hairs. They also lubricate the skin, and so maintain its elasticity, and serve, moreover, to eliminate hydro-carbons or fatty matters, from the system. They are extremely numerous, as may be inferred from their connection with the hairs.—*Abridged from a Paper by* Dr. Ashe.

MECHANISM OF THE SPINAL COLUMN.

The backbone, or *spinal column*, as it is anatomically termed, serves three great purposes: it is the great bond of union betwixt all the parts of the skeleton; it forms a tube for the lodgement of the spinal marrow, a part of the nervous system as important to life as the brain itself; and lastly, it is a column to sustain the head.

If the protection of the spinal marrow had been the only object of this structure, it is natural to infer that it would have been a strong and unyielding tube of bone; but, as it must yield to the inflections of the body, it cannot be constituted in so strict an analogy with the skull. It must, therefore, bend; but it must have no abrupt or considerable bending at one part, for the spinal marrow within would in this way suffer.

By this consideration we perceive why there are twenty-four bones in the spine, each bending a little; each articulated or making a joint with its fellow; all yielding in a slight degree, and, consequently, permitting in the whole spine that flexibility necessary to the motions of the body. It is next to be observed, that whilst the spine by this provision moves in every direction, it gains a property which it belongs more to our present purpose to understand. The bones of the spine are called vertebræ; at each interstice between these bones there is a peculiar gristly substance, which is squeezed out from betwixt the bones, and therefore permits them to approach and play a little in the motions of the body. This gristly substance is enclosed in an elastic binding or membrane of great strength, which passes from the edge

or border of one vertebra to the border of the one next it. When a weight is upon the body, the soft gristle is pressed out, and the membrane yields; the moment the weight is removed, the membrane recoils by its elasticity, the gristle is pressed into its place, and the bones resume their position.

We can readily understand how great the influence of these twenty-four joinings must be in giving elasticity to the whole column; and how much this must tend to the protection of the brain. Were it not for this interposition of elastic material, every motion of the body would produce a jar to the delicate texture of the brain, and we should suffer almost as much in alighting on our feet as in falling on our head. It is, as we have already remarked, necessary to interpose thin plates of lead or slate between the different pieces of a column, to prevent the edges (technically called *arrises*) of the cylinders from coming in contact, as they would in that case chip or split off.

But there is another very curious provision for the protection of the brain: we mean the curved form of the spine. If a steel spring, perfectly straight, be pressed betwixt the hands from its extremities, it will resist, notwithstanding its elasticity; and when it does give way, it will be with a jerk. Such would be the effect on the spine if it stood upright, one bone perpendicular to another; for then the weight would bear equally—the spine would yield neither to one side nor to the other; and, consequently, there would be a resistance from the pressure on all sides being balanced. We therefore see the great advantage resulting from the spine being in the form of an italic *f*. It is prepared to yield in the direction of its curves; the pressure is of necessity more upon one side of the column than on the other; and its elasticity is immediately in operation without a jerk. It yields, recoils, and so forms the most perfect spring; admirably calculated to carry the head without jar or injury of any kind.

The most unhappy illustration of all this is the condition of old age. The tables of the skull are then consolidated, and the spine is rigid: if an old man should fall with his head upon the carpet, the blow, which would be of no consequence to the elastic

frame of a child, may to him prove fatal; and the rigidity of the spine makes every step which he takes vibrate to the interior of the head, and jar on the brain.—*Abridged: Library of Useful Knowledge.*

ANIMAL ADAPTATION TO EXTERNAL CONDITIONS.

The fitness of different animals, by their bodily structure, to the circumstances in which they are found, presents an endless subject of curious inquiry and pleasing contemplation. Take, for example, the foot in three well-known creatures—the Camel, the Horse, and the Rein-deer.

The *Camel*, which lives in sandy deserts, has broad spreading hoofs to support him on the loose soil; and an apparatus in his body by which water is kept for many days, to be used when no moisture can be had. As this would be useless in the neighbourhood of streams or wells, and as it would be equally so in the desert, where no water is to be found, there can be no doubt that it is intended to assist in journeying across the sands from one watered spot to another. There is a singular and beautiful provision made in this animal's foot, for enabling it to sustain the fatigue of journeys under the pressure of its great weight. Besides the yielding of the bones and ligaments, or bindings, which gives elasticity to the foot of the deer and other animals, there is in the camel's foot, between the horny sole and the bones, a cushion, like a ball, of soft matter almost fluid, but in which there is a mass of threads extremely elastic interwoven with the pulpy substance. The cushion thus easily changes its shape when pressed, yet it has such an elastic spring, that the bones of the foot press on it uninjured by the heavy body which they support, and this huge animal steps as softly as a cat.

Nor need we flee to the desert in order to witness an example of skilful structure: the limbs of the *Horse* display it strikingly. The bones of the foot are not placed directly under the weight; if they were in an upright position they would make a firm pillar, and every motion would cause a shock. They are placed

slanting or oblique, and tied together by an elastic binding on their lower surfaces, so as to form springs as exact as those which we make of leather and steel for carriages. Then the flatness of the hoof, which stretches out on each side, and the frog coming down in the middle between the quarters, adds greatly to the elasticity of the machine. Ignorant of this, ill-informed farriers nail the shoe in such a manner as to fix the quarters, and cause permanent contraction of the bones, ligaments, and hoof—so that the elasticity is destroyed; every step is a shock—inflammation and lameness ensue.

The *Rein-deer* inhabits a country covered with snow the greater part of the year. Observe how admirably his hoof is formed for going over that cold and light substance, without sinking in it or being frozen. The under side is covered entirely with hair of a warm and close texture; and the hoof, altogether, is very broad, acting exactly like the snow-shoes which men have constructed for giving them a larger space to stand on than their feet, and thus avoid sinking. Moreover, the deer spreads the hoof as wide as possible when it touches the ground: but as this breadth would be inconvenient in the air, by occasioning a greater resistance while he is moving along, no sooner does he lift the hoof than the two parts into which it is cloven fall together, and so lessen the surface exposed to the air—just as we may recollect the birds doing with their bodies and wings. The shape and structure of the hoof are also well adapted to scrape away the snow, and enable the animal to get at the particular kind of moss (or *lichen*) on which he feeds. This plant, unlike others, is in its full growth during the winter season; and the rein-deer accordingly thrives, from its abundance, at the season of his greatest use to man, notwithstanding the unfavourable effects of extreme cold upon the animal system.—BROUGHAM'S *Objects and Pleasures of Science.*

PHYSICAL.

THE VISIBLE UNIVERSE.

According to the delusive testimony of our eyesight, the sun and all the planets move round our Earth, as if it were the centre of the universe. We see the sun and moon rise and set, and the stellar canopy slowly revolving round the polar star. But we seem to repose in majestic immobility, and thus it appears as if all those luminous worlds acknowledged the supremacy of our globe, and paid homage to its superior power.

For thousands of years Science itself remained inthralled by these delusive appearances, until at length the master mind of Copernicus reduced our planet to the rank of an humble follower of that sun which it had so long appeared to rule. This great man first convincingly proved that the sun does not revolve round the Earth, but that we and all the planets circle round the sun; and that the Earth, by turning on her axis every twenty-four hours from west to east, produces that apparent movement of the starry heavens from east to west which had deceived all previous astronomers. Building still further on the Copernican system, the illustrious Kepler next showed that the planets do not move in circles but in ellipses round the sun, and discovered the laws* which regulate the swiftness and proportions of their orbits. Twelve years after that great man's death, our immortal Newton was born, who proved that the movements of all the celestial

* These laws, known as *Kepler's Laws*, are the following:—1. That every planet moves so that the line drawn from it to the sun describes about the sun areas proportional to the times. 2. That the planets all move in elliptic orbits, of which the sun occupies one of the foci. And, 3. That the squares of the times of the revolutions of the planets are as the cubes of their mean distances from the sun.

bodies flow from the supreme law of universal gravitation, or the mutual attraction of bodies according to the proportion of their masses and distances. By means of this fundamental law,* which regulates the movements of the stars as well as the fall of terrestrial bodies, the course of waters, the motions of the pendulum, and the direction of the loadline, it was now possible to solve many most difficult problems, which until then had baffled the sagacity of the greatest mathematicians and astronomers—to explain the precession of the equinoxes, to determine the weight and the masses of the various bodies of the solar system, and, finally, to calculate the perturbations resulting from the mutual attractions of the planets.

The word *perturbation* (Lat. *perturbatio*, a disturbance) might possibly lead us to fear that at a period, however remote, the laws which maintain the planets in their courses might ultimately be overcome by counteracting forces, and an irreparable catastrophe be the consequence; but the calculations of Laplace have proved that all alarms on the subject are perfectly groundless, for the planetary perturbations are as subject to eternal laws as all the other motions of the heavenly bodies. They never exceed a certain limit, they mutually correct each other, and cannot possibly become dangerous. Thus, by an admirable mechanism, worthy of the Supreme Architect of worlds, even the deviations of the planets contribute to the eternal harmony of the spheres.

When Herschel discovered Uranus, that dim planet, which receives the faint rays of the sun from a distance of 1,600,000,000 geographical miles, it was supposed that the utmost limits of our solar system had been attained, and that beyond must begin the vast solitudes which separate the dominions of our sun from those of the nearest fixed star. But Uranus showed perturbations in his path which could not be accounted for by the attraction of Saturn, and could therefore only be ascribed to an unknown planet. The calculations of Adams and Le Verrier determined

* The *Laws of Gravitation* as laid down by Newton, and universally admitted, are as follows :—The gravitating forces of bodies are to each other—1. Directly as their masses ; and, 2. Inversely as the squares of their distances.

the position and the mass of this new celestial body; and scarcely had they pointed out the spot where, according to all probability, it must be revolving through space, than the telescope of the Berlin astronomer Galle verified the accuracy of their statements, and discovered Neptune, circulating as a star of the eighth magnitude, 2,800,000,000 miles from the sun. Possibly other planets may still roll beyond Neptune, which, perhaps, no telescope may ever be able to detect; but from the perturbations they may cause, their existence will be as evident as if we could follow them on their lustrous path.

Besides the planets, and moons, and numerous comets, a vast number of smaller planetary bodies, partly disseminated, partly grouped in annular zones, revolve in elliptic orbits round the sun. When these small planetary bodies come within the sphere of the Earth's attraction they obey its influence, and, darting down, give rise to the phenomena of shooting stars and meteoric stones. On a bright night twenty minutes rarely pass, at any part of the Earth's surface, without the appearance of at least one meteor. At certain times (the 12th of August and 14th of November, when, in all probability, our Earth crosses the orbit of one of those annular zones) they appear in enormous numbers. The number falling in a year might, perhaps, be estimated at hundreds or thousands of millions; and even these would constitute but a small portion of the total crowd of asteroids that circulate round the sun. As these bodies, while obeying the Earth's attraction, traverse our atmosphere with planetary velocity, they would no doubt cause a terrible bombardment, and from their vast number render our planet absolutely uninhabitable, if their speed had not been the means of neutralizing their otherwise disastrous effects. For, raised to incandescence by the atmospheric friction engendered by this enormous velocity of from eighteen to thirty-six miles a second, by far the greater portion of the aerolites are dissipated by heat, and a small number only reach the surface of the Earth under the solid form of meteoric stones.

Interesting on account of their celestial origin, the masses are still more so as the only *tangible* and *ponderable* proofs we possess of the

material existence of a world beyond our own—as teaching us that the substances of which our Earth is composed exist also beyond its limits; for the chemist finds the meteoric stones composed of iron, nickel, cobalt, silica, aluminium, and other terrestrial elements, nor do they contain a single atom of any substance that is unknown to us on Earth. This circumstance sufficed to render it very probable that our whole solar system has been constructed of identical materials; but the wonderful researches of Bunsen and Kerchoff (spectrum analysis) have raised probability to certainty, by proving that sodium, calcium, magnesium, chromium, iron, and other metals, are constituents of the solar atmosphere and of the sun's central orb.

However vast the scale of our planetary system, however incapable our imagination may be to grasp its immensity, it still forms but a minute portion even of the visible universe; for how insignificant, in point of number, size, and distance, are all the satellites revolving round the sun, in comparison with the countless hosts of the sidereal or starry heavens! So enormous are their distances, that the immense diameter of the Earth's orbit, as seen from them, is only an indivisible point; and it is only within the last few years that instruments of a precision unknown to former ages have at length brought a small number of them within the reach of human calculation. Thus the distances of about thirty of the nearest fixed stars have been measured; but the remaining thousands which we are able to see with the naked eye, and the millions which the telescope reveals to our gaze, roll on at such immense distances from our planet, that most probably no progress of astronomical science will ever be able to bridge over the intervening gulf.

At the beginning of the present century, the *fixed stars*, our sun among the rest, were still supposed to be immovable, since, as far as our astronomical annals reach, no change has ever been observed in their mutual positions: but the wonderful precision of our modern instruments, and the progress of astronomical observation, have taught us that they by no means deserve the name. As we and all our brother-planets are circling round the

sun, so also the sun with all his satellites careers through space at the rate of 800,000 miles a day; but the time of observation is as yet too short to enable us to ascertain the centre of this prodigious orbit. Similar motions have been discovered in other fixed stars, and thus we can hardly doubt that all the spheres of our "world-island" (as Humboldt appropriately calls the solar system) are engaged in constant motion—nay, that our world-island itself revolves round another, and that this eternal motion pervades all the recesses of the universe. As the planets revolve in regular order round the sun; as the comets, however far they may roam in their erratic course, are yet obliged, in obedience to the law of gravitation, to return to their central orb; as within the comparatively narrow confines of our solar system the beautiful spectacle of order, regularity, and unity, strikes us in every detail;—so also we cannot possibly doubt that the same order, the same harmony, the same unity of plan, pervade all the unknown recesses of the universe, and that the whole of the amazing structure proclaims, in all its parts, throughout all time and space, the infinite power and wisdom of the Creator.—*Adapted and abridged from* HARTWIG's *Harmonies of Nature.*

PHYSICAL CONSTITUTION OF THE SUN.

WHEN viewed through powerful telescopes, provided with coloured glasses to take off the heat, which would otherwise injure our eyes, the sun is observed to have frequently large and perfectly black spots upon it, surrounded by a kind of border, less completely dark, called a penumbra. They are, however, not permanent. When watched from day to day, or even from hour to hour, they appear to enlarge or contract, to change their forms, and at length to disappear altogether, or to break out anew in parts of the surface where none were before. In such cases of disappearance, the central dark spot always contracts into a point, and vanishes before the border. Occasionally they break up, or divide into two or more; and in those cases offer every evidence

of that extreme mobility which belongs only to the fluid state, and of that excessively violent agitation which seems only compatible with the atmospheric or gaseous state of matter. The scale on which their movements take place is immense. A single second of angular measure, as seen from the Earth, corresponds on the sun's disc to 461 miles; and a circle of this diameter (containing, therefore, nearly 167,000 square miles) is the least space which can be distinctly discerned on the sun as a *visible area*. Spots have been observed, however, whose linear diameter has been upwards of 45,000 miles; and even, if some records are to be trusted, of very much greater extent. That such a spot should close up in six weeks' time (for they seldom last much longer), its borders must approach at the rate of more than 1000 miles a day.

Many other circumstances tend to corroborate this view of the subject. The part of the sun's disc not occupied by spots is far from uniformly bright. Its *ground* is finely mottled with an appearance of minute dark dots, or *pores*, which, when attentively watched, are found to be in a state of perpetual change. There is nothing which represents so faithfully this appearance as the slow subsidence of some flocculent chemical precipitates in a transparent fluid, when viewed perpendicularly from above; so faithfully, indeed, that it is hardly possible not to be impressed with the idea of a luminous medium intermixed, but not confounded, with a transparent and non-luminous atmosphere, either floating as clouds in our air, or pervading it in vast sheets and columns like flame, or the streamers of our northern lights, directed in lines perpendicular to the surface. Lastly, in the neighbourhood of great spots, or extensive groups of them, large spaces of the surface are often observed to be covered with strongly marked curved or branching streaks, more luminous than the rest, called *faculæ;* and among these, if not already existing, spots frequently break out. They may, perhaps, be regarded with most probability as the ridges of the sun's atmosphere, indicative of violent agitation in their neighbourhood. They are most commonly, and best seen, towards the borders of the visible disc.

But what are the spots? Many fanciful notions have been broached on this subject, but only one seems to have any degree of physical probability—viz., that they are the dark, or at least comparatively dark, solid body of the sun itself, laid bare to our view by those immense fluctuations in the luminous regions of its atmosphere to which it appears to be subject. When the spots are attentively watched, their situation on the disc of the sun is observed to change. They advance regularly towards its western limb or border, where they disappear, and are replaced by others which enter at the eastern limb, and which, pursuing their respective courses, in their turn disappear at the western. The apparent rapidity of this movement is not uniform, as it would be were the spots dark bodies passing, by an independent motion of their own, between the Earth and the sun, but is swiftest in the middle of their paths across the disc, and very slow at the borders. This is precisely what would be the case supposing them to appertain to and make part of the visible surface of the sun's globe, and to be carried round by a uniform rotation of that globe on its axis, so that each spot should describe a circle parallel to the sun's equator, rendered elliptic by the effect of perspective. Their apparent paths also across the disc conform to this view of their nature, being, generally speaking, ellipses, much elongated, concentric with the sun's disc, each having one of its chords for its longer axis, and all these axes parallel to each other.—HERSCHEL'S *Outlines of Astronomy*.

SHOOTING STARS, METEORS, AND AËROLITES.

A CAREFUL observer, directing his attention towards any quarter of the sky on a clear night, will see, on an average, six *shooting stars* per hour. We may assume, therefore, that about fifteen appear above the horizon of any place during each hour. More appear after than before midnight, the most favourable time for observation being from one o'clock till three. In tropical climates shooting stars are seen oftener, and shine far more

brilliantly than in our northern latitudes. This peculiarity is due, no doubt, to the superior purity and serenity of the air within and near the tropics, not to any real superiority in the number of the falling stars. Sir Alexander Burnes, speaking of the transparency of the dry atmosphere of Bokhara, a place not further south than Madrid, but raised 1200 feet above the level of the sea, says: "The stars have uncommon lustre, and the milky way shines gloriously in the firmament. There is also a never-ceasing display of the most brilliant meteors, which dart like rockets in the sky: ten or twelve of them are sometimes seen in an hour, assuming every colour—fiery-red, blue, pale, and faint."—In our climate about two-thirds of all the shooting-stars seen are white; next in frequency come yellow stars, one yellow star being seen for about five white stars; there are about twice as many yellow as orange stars, and more than twice as many orange as green or blue stars.

Meteors or *fire-balls* are less common than shooting stars. They are magnificent objects, their brilliancy often exceeding that of the full moon. Some have even been so brilliant as to cast a shadow in full daylight. They are generally followed by a brilliant luminous train, which seems to be drawn out of the substance of the fire-ball itself. Their motion is not commonly uniform, but, so to speak, impulsive; they often seem to follow a waved or contorted path; their form changes visibly, and in general they disappear with a loud explosion. Occasionally, however, a meteor will be seen to separate, without explosion, into a number of distinct globes, accompanying each other in parallel courses, and each followed by a train. "Sometimes," says Kaemtz in his "Meteorology," "a fire-ball is divided into fragments, each of which forms a luminous globe, which then bursts in its turn; in others, the mass, after having given vent to the interior gases, closes in upon itself, and then swells out anew to burst a second time." Meteors which move impulsively, generally burst at each bound, giving forth smoke and vapours, and shining afterwards with a new lustre. In some instances, the crash of the explosion is so great that "houses tremble, doors

and windows open, and men imagine there has been an earthquake."

Aërolites, or *meteoric stones*, are bodies which fall from the sky upon the earth. They are less common than meteors, but that they are far from being uncommon is shown by this, that in the British Museum alone there are preserved several hundreds of these bodies. They vary greatly in size and form; some being no larger than a man's fist, while others weigh many hundreds of pounds. Marshal Bazaine has lately brought from Mexico a meteorite weighing more than three-quarters of a ton; but this weight has been far exceeded in several cases. Thus, a meteorite was presented to the British Museum in 1865 which weighs not less than three and a half tons. It had been found near Melbourne, and one half of the mass had been promised to the Melbourne Museum. But fortunately it was saved from injury. A meteorite weighing one and a quarter tons, which had been found close to the greater one, was transferred from the British to the Melbourne Museum, and the great meteorite forwarded unbroken to our national collection. A yet larger meteorite lies on the plain of Tucuman in North America. It has not been weighed, but measurement shows that its weight cannot fall short of fourteen or fifteen tons. It is from seven to seven feet and a half in length.

Various theories were offered by the ancients and by our forefathers for the occurrence of these celestial phenomena. By some they were regarded as gaseous exhalations in a state of ignition; by others, as formed by the accretion of metallic vapours in the upper atmosphere: by some, as ejections from terrestrial volcanoes; and by others, again, as discharges from the volcanoes of the moon, or even discharges of burning matter from the sun himself. Modern observation, however, has dispelled all these hypotheses. Shooting stars are first seen at about seventy miles from our Earth, and disappear when at the distance of fifty miles. Meteors have been examined by the spectroscope, and found to contain sodium, potassium, sulphur, phosphorus, and other terrestrial elements. And aërolites have been analyzed and shown to consist of metallic iron, magnetic iron, sulphate of iron,

oxide of tin, nickel, silicates, olivine, &c. The distances at which they appear, the numbers in which they occur, and the periodicity of their recurrence, as well as their material composition, have led to the belief that they are of the nature of planetary bodies. The discovery of a zone of planetoids, the inquiry into the nature of the zodiacal light, and the mathematical examination of the "stability" of the Saturnian ring system, also corroborate this view, and have led astronomers to recognize the existence in the solar system of minute bodies, travelling in zones or clusters round a central orb. There is, therefore, nothing unreasonable in the supposition that there are zones and clusters of such bodies travelling round the sun in orbits which intersect the Earth's path. When, in her course round the sun, the Earth encounters any of the bodies forming such zones and clusters, they are ignited by friction as they pass through the upper layers of the air, and become visible as *shooting stars*, or *meteors*, according to their dimensions, or they may even fall upon her surface as *aërolites.—Adapted from the Cornhill Magazine for November* 1867.

LIGHT AND SOUND.

What is Light? The ancients supposed it to be something emitted by the eyes, and for ages no notion was entertained that it required time to pass through space. In the year 1676 Römer first proved that the light from Jupiter's satellites required a certain time to cross the Earth's orbit. Bradley afterwards found that, owing to the velocity with which the Earth flies through space, the rays of the stars are slightly inclined—just as rain-drops which descend vertically appear to meet us when we move swiftly through a shower. Knowing the velocity of the Earth, and the inclination of the stellar rays, Bradley was able to calculate the velocity of light; and his result agrees closely with that of Römer. Celestial distances were here involved, but a few years ago M. Fizeau, by an extremely ingenious contrivance, determined the time required by light to pass over a distance of about 9000

yards; and his experiment is quite in accordance with the results of his predecessors.

But what is it which thus moves? Some, and among the number Newton, imagined light to consist of particles darted out from luminous bodies. This is the so-called *Emission Theory*, which was held by some of the greatest men. Laplace, for example, accepted it; and M. Biot has developed it with a lucidity peculiar to himself. It was first opposed by the astronomer Huyghens, and afterwards by Euler, both of whom supposed light to be a kind of undulatory motion; but they were borne down by their great antagonists, and the emission theory held its ground until the commencement of the present century, when Thomas Young, Professor of Natural Philosophy in the Royal Institution, reversed the scientific creed by placing the *Theory of Undulation* on firm foundations. He was followed by a young Frenchman of extraordinary genius, who, by the force of his logic and the conclusiveness of his experiments, left the Wave Theory without a competitor. The name of this young Frenchman was Augustin Fresnel. Since his time some of the ablest minds in Europe have been applied to the investigation of this subject; and thus a mastery, almost miraculous, has been attained over the grandest and most subtle of natural phenomena.

True knowledge is always fruitful, and a clear conception regarding any one natural agent leads infallibly to better notions regarding others. It is known, for instance, that sound is conveyed to our organs of hearing by the air: a bell struck in a vacuum emits no sound, and even when the air is thin the sound is enfeebled. Hawksbee proved this by the air-pump; De Saussure fired a pistol on the top of Mont Blanc. I have repeated the experiment myself, and found, with him, that the sound is feebler than at the sea-level. Sound is not produced by anything projected through the air. The explosion of a gun, for example, is sent forward by a motion of a totally different kind from that which animates the bullet projected from the gun: the latter is a motion of *translation*, the former one of *vibration*. To use a rough comparison, sound is projected through the air as a push is through a crowd; it is

the propagation of a *wave* or *pulse*, each particle taking up the motion of its neighbour, and delivering it on to the next. These aërial waves enter the external ear, meet a membrane, the so-called tympanic membrane, which is drawn across the passage at a certain place, and break upon it as sea-waves do upon the shore. The membrane is shaken, its tremors are communicated to the auditory nerve, and transmitted by it to the brain, where they produce the impression to which we give the name of *sound*.

Musical sounds differ in *pitch*: some notes are high and shrill, others low and deep. Boys are chosen as choristers, to produce the shrill notes; men are chosen to produce the bass notes. Now the sole difference here is, that the boy's organ vibrates *more rapidly* than the man's—it sends a greater number of impulses per second to the ear. In like manner, a short string emits a higher note than a long one, because it vibrates more quickly. The greater the number of vibrations which any instrument performs in a given time, the higher will be the pitch of the note produced. The reason why the hum of a gnat is shriller than that of a beetle is that the wings of the small insect vibrate more quickly than those of the larger one.

In the study of nature, the coarser phenomena, which come under the cognizance of the senses, often suggest to us the finer phenomena, which come under the cognizance of the mind; and thus the vibrations which produce sound, and which can be rendered visible to the eye by proper means, first suggested that light might be due to a somewhat similar action. This is now the universal belief. A luminous body is supposed to have its atoms, or molecules, in a state of intense vibration. The motions of the atoms are supposed to be communicated to a medium suited to their transmission, as air is to the transmission of sound. This medium is called the *luminiferous ether*, and the little waves excited in it speed through it with amazing celerity, enter the pupil of the eye, pass through the humours, and break upon the retina or optic nerve, which is spread out at the back of the eye. Hence the tremors they produce are transmitted

along the nerve to the brain, where they announce themselves as *light*. The swiftness with which the waves of light are propagated through the ether is, however, enormously greater than that with which the waves of sound pass through the air. An aërial wave of sound travels at about the rate of 1100 feet in a second; a wave of light leaves 192,000 miles behind it in the same time!

Thus, then, in the case of sound, we have the sonorous body, the air, and the auricular nerve, concerned in the phenomenon; in the case of light, we have the luminous body, the ether, and the optic nerve. The fundamental analogy of sound and light is thus before us, and it is easily remembered.

But we must push the analogy further. We know that the white light which comes to us from the sun is made up of an infinite number of coloured rays. By refraction with a prism we can separate those rays from each other, and arrange them in a series of colours which constitute the solar spectrum. The rainbow is an imperfect or *impure* spectrum, produced by the drops of falling rain; but by prisms we can unravel the white light into pure red, orange, yellow, green, blue, indigo, and violet. Now this spectrum is to the eye what the gamut is to the ear: each colour represents a note, and *the different colours represent notes of different pitch*. The vibrations which produce the impression of red are *slower*, and the waves which they produce are *longer*, than those to which we owe the sensation of violet; while the vibrations which excite the other colours are intermediate between these two extremes. This, then, is the second grand analogy between light and sound: *Colour answers to Pitch*. There is therefore truth in the figure when we say that the gentian of the Alps sings a shriller note than the wild rhododendron, and that the red glow of the mountains at sunset is of a lower pitch than the blue of the firmament at noon. These are not fanciful analogies. To the mind of the philosopher these waves of ether are almost as palpable and certain as the waves of the sea or the ripples on the surface of a lake.

A third and most important analogy between sound and light

is now to be noted, and it will be best understood by reference to something more tangible than either. When a stone is thrown into calm water, a series of rings spread themselves around the centre of disturbance. If a second stone be thrown in at some distance from the first, the rings emanating from both centres will cross each other, and at those points where the ridge of one wave coincides with the ridge of another the water will be lifted to a greater height. At those points, on the contrary, where the ridge of one wave crosses the furrow of another, we have both obliterated, and the water restored to its ordinary level. Where two ridges or two furrows unite, we have a case of *coincidence;* but where a ridge and a furrow unite, we have what is called *interference.* It is quite possible to send two systems of waves into the same channel, and to *hold back* one system a little, so that its ridges shall coincide with the furrows of the other system. The "interference" would be here complete, and the waves thus circumstanced would mutually destroy each other, smooth water being the result. In this way, by the addition of motion to motion, *rest* may be produced.

In a precisely similar manner two systems of sonorous waves can be caused to interfere and mutually to destroy each other: thus by adding sound to sound *silence* may be produced. Two beams of light also may be caused to interfere and effect their mutual extinction: thus by adding light to light we can produce *darkness.* Here, indeed, we have a critical analogy between sound and light—*the* one, in fact, which compels the most profound thinkers of the day to assume that light, like sound, is a case of undulatory motion.—*Abridged from* PROFESSOR TYNDALL'S *Glaciers of the Alps.*

THUNDER AND LIGHTNING.

THE analogy between the electric spark and lightning was noticed at an early period of electrical science. In 1708 Dr. Wall pointed out a resemblance between them; in 1735 Grey conjectured their

identity; in 1748 the Abbè Nollet reproduced the conjecture of Grey with more substantial reasons; and in 1752 the great American philosopher, Franklin, *demonstrated* the identity by the bold experiment of bringing down lightning from the heavens by means of a kite, and by performing with it experiments similar to those usually made with ordinary electricity. The following is the account transmitted to us of this grand experiment:—"He prepared his kite by making a small cross of two light strips of cedar, the arms of sufficient length to extend to the four corners of a large silk handkerchief stretched upon them; to the extremities of the arms of the cross he tied the corners of the handkerchief. This being properly supplied with a tail long and strong, could be raised in the air like a common paper kite; and being made of silk, was more capable of bearing rain and wind. To the upright shaft of the cross was attached an iron point, the lower end of which was in contact with the string by which the kite was raised, which was a hempen cord. At the lower extremity of this cord, near the observer, a key was fastened; and in order to intercept the electricity in its descent and prevent it from reaching the person who held the kite, a silk ribbon was tied to the ring of the key, and continued to the hand by which the kite was held. Furnished with this apparatus, on the approach of a storm he went out upon the common near Philadelphia, accompanied by his son, to whom alone he communicated his intentions, well knowing the ridicule which would attend the report of such an attempt should it prove unsuccessful. Having raised the kite, he placed himself under a shed, that the ribbon by which it was held might be kept dry, as it would become a conductor of electricity when wetted by rain, and so fail to afford that protection for which it was provided. A cloud apparently charged with electricity soon passed directly over the kite. Franklin observed the hempen cord, but no bristling of its fibres was apparent, such as was wont to take place when it was electrified. He presented his knuckle to the key, but not the smallest spark was perceptible. After the lapse of some time, however, he saw that the fibres of the cord near

the key bristled and stood on end. He presented his knuckle to the key and received a strong bright spark. *It was lightning!* A shower now fell which, wetting the cord of the kite, improved its conducting power; sparks in rapid succession were drawn from the key; a Leyden jar was charged with it, and a shock was given;—in fine, all the experiments which were wont to be made of electricity were reproduced identical in all their concomitant circumstances."

Franklin's experiment was eagerly repeated in almost every civilized country, and with variable success. In France a grand result was obtained by Romas, who constructed a kite seven feet high, which he raised to the height of 550 feet by a string having a fine wire interwoven throughout its whole length. It is stated that on the 26th of August 1756, flashes of fire *ten feet long* were given off from this conductor. In 1753, Professor Richman of St. Petersburg was struck dead by a flash of lightning from an exploring apparatus he had erected for the purpose of repeating Franklin's experiment.

Lightning and thunder, then, are atmospheric electrical phenomena, and a thunderstorm is the result of an electric disturbance arising from the accumulation of active electricity in masses of vapour condensed in the atmosphere. Agreeably with the laws of induction, a mass of electrified vapour determines an opposite electrical state over that portion of the Earth's surface directly opposed to it; the particles of intervening air assume a peculiar, forced, electrical state, which has been termed "polarized;" and when the tension has been raised to a certain point, and the particles can no longer resist the tendency of the opposite electrical forces to combine, they are displaced and broken through with a greater or less degree of mechanical violence. The clouds and the earth, or two oppositely electrified clouds, correspond to the coatings, and the intervening air to the glass, of the Leyden phial, and the thunderstorm is the charging and discharging of this huge system. The snap attending the spark from the prime conductor, and the awful thunder-crash, are undoubtedly similar phenomena, and produced by the same action. The cause is the

vibration of the air, agitated by the passage of the electric discharges with a greater or less degree of intensity.

A great difference may be observed in the appearance of the flashes of lightning during a thunderstorm. The scene is sometimes rendered awfully magnificent by their brilliancy, frequency, and extent; darting sometimes in broad and well-defined lines from cloud to cloud, and sometimes shooting towards the Earth; they then become zig-zag and irregular, or appear as a large and rapidly moving ball of fire—an appearance usually designated by the ignorant a *thunderbolt*, and erroneously supposed to be attended by the fall of a solid body. The report of the thunder is also modified according to the nature of the country, the extent of the air through which it passes, and the position of the observer. Sometimes it sounds like the sudden emptying of a large cart-load of stones, sometimes like the firing of a volley of musketry—and in these cases it usually follows the lightning immediately, and is near at hand. When more distant, it rumbles and reverberates at first with a loud report, gradually dying away, and returning at intervals, or roaring like the discharges of heavy artillery. In accounting for these phenomena, it must be remembered that the passage of electricity is almost infinitely rapid. A discharge through a circuit of many miles has been experimentally proved to be instantaneous. The motion of light is similarly rapid, and hence the flash appears momentary, however great the distance through which it passes; but sound is vastly slower in its progress, travelling only at the rate of 1115 feet per second. Now, supposing the lightning to pass through a space of some miles, the explosion will be first heard from the point of the air agitated nearest the spectator, it will gradually come from the more distant parts of the course of the electricity, and last of all it will be heard from the remote extremity; and the different degrees of agitation of the air, and likewise the difference of the distance will account for the different intensities of the sound and the reverberation.—*Adapted from* NOAD's *Text-Book of Electricity.*

LIGHTNING AND LIGHTNING-CONDUCTORS.

According to Sir William Snow Harris, in his *Essay on the Nature of Thunderstorms*, "it is more than probable that the varied appearances of lightning are owing to the common progress of the disruptive discharge modified by the quantity of passing electricity, the density and condition of the air, and the brilliancy of the attendant light. When the state of the atmosphere is such that a moderately intense discharge can proceed in an occasionally deviating zig-zag line, the great nucleus or head of the discharge becomes drawn out as it were into a line of light visible through the whole track; and if the discharge divides on approaching a terrestrial object, we have what sailors call '*forked-lightning;*' if it does not divide, but exhibits a long rippling line, with but little deviation, they call it '*chain-lightning.*' What sailors term '*sheet-lightning*' is the light of a vivid discharge reflected from the surface of distant clouds, the spark itself being concealed by a dense intermediate mass of cloud, behind which the discharge has taken place. In this way an extensive range of cloud may appear in a blaze of light, producing a truly sublime effect. The appearance termed '*globular-lightning*' may be the result of similar discharges: it is, no doubt, always attended by a diffusely luminous track; this may, however, be completely eclipsed in the mind of the observer by the great concentration and density of the discharge in the points through which it continues to force its way, and where the condensation of the air immediately before it is often extremely great. It is this intensely luminous point which gives the notion of globular discharges; and it is clear, from the circumference of air which may become illuminated, the apparent diameter will often be great."

With regard to positions of safety during a thunderstorm, it may be remarked that, if out of doors, trees should be avoided; and if, from the rapidity with which the explosion follows the flash, it should be evident the electric clouds are near at hand, a

recumbent position on the ground is the most secure. It is seldom dangerous to take shelter under sheds, carts, low buildings, or the arch of a bridge. The distance of twenty or thirty feet from tall trees or houses is rather an eligible situation; for should a discharge take place, these elevated bodies are likely to receive it, and less prominent bodies in the neighbourhood more likely to escape. It is right to avoid *water*, for it is a good conductor, and the height of a human being near the stream is not unlikely to determine the direction of a discharge. Within doors we are tolerably safe in the middle of a carpeted room, or when standing on a double hearth-rug. The chimney should be avoided, as when a building is struck with lightning, the charge is generally determined towards it in consequence of the good conducting power of the carbon or soot; and upon the same principle, gilt mouldings, window-rods, bell-wires, and the like, are in danger of being struck. In bed we are tolerably safe, blankets and feathers being bad conductors, and we are consequently to a certain extent insulated. It is injudicious to take refuge in a cellar, for it has sometimes happened that buildings that have been struck by lightning have sustained the greatest injury in the ground story.

Franklin was the first to suggest a method of defending buildings from the effects of lightning. His plan was to erect by the side of the building a continuous metallic rod in perfect communication with the earth; and experience has fully demonstrated the value of this precaution. The metal should be copper; the rod, about one inch in diameter, should be carried above the highest point of the building; and it should penetrate the ground sufficiently deep to come in contact with moist soil. It should be applied as closely as possible to the walls of the building, and all contiguous masses of metal, gutters, water-pipes, &c., should be metallically connected with it; for although there is no danger of a properly arranged lightning-conductor throwing off *lateral sparks* to any semi-insulated metallic masses near it, the charge may in its course *divide* between the rod and other metallic bodies in its neighbourhood in good connection with the earth.

The action of the conductor is purely passive; it offers to the disruptive discharge a line of small resistance whereby those irresistible mechanical effects which attend the passage of the discharge through resisting matter are prevented. When large masses of straggling buildings are to be protected, two or more conductors should be applied, and the whole connected by bands of metal. Sir W. Harris recommends that the conductors should be constructed of copper pipe, from one to two inches in diameter, and about one-fifth of an inch thick. It may be prepared in lengths of about ten feet, and united at the time of fixing, by screwing the lengths together upon short intermediate pieces.

When a very dense electrical explosion falls on a conductor, the rod sometimes becomes covered with a luminous glow, and a loud whizzing sound is at the same time heard. This luminous appearance is, however, of a perfectly harmless character, and provided the conductor be of sufficient capacity, it is unattended with any calorific effect. It appears to be a sort of glow discharge between the metal and the air, immediately in the point of contact, and may be classed with the phosphorescent flashes attendant on the aurora borealis, or with the streaming of ordinary electricity in the exhausted receiver of an air-pump.—*Adapted from* NOAD'S *Text-Book of Electricity.*

THE COLOUR OF WATER.

THE purest water with which we are acquainted is undoubtedly that which falls from the atmosphere. Having touched air alone, it can contain nothing but what it gains from the atmosphere, and it is distilled without the chance of those impurities which may exist in the vessels used in artificial operation. We cannot well examine the water precipitated from the atmosphere as rain without collecting it in vessels, and all artificial contact gives more or less of contamination; but in snow, melted by the sunbeams, that has fallen on glaciers, themselves formed from frozen

snow, water may be regarded as in its state of greatest purity. Congelation expels both salts and air from water, whether existing below or formed in the atmosphere; and in the high and uninhabited regions of glaciers there can scarcely be any substances to contaminate. Removed from animal and vegetable life, they are even above the mineral kingdom; and though there are instances in which the rudest kind of vegetation (of the fungus or mucor kind) is even found upon snows, yet this is a rare occurrence; and red snow, which is occasioned by it, is an extraordinary, and not a common phenomenon, towards the pole, and on the highest mountains of the globe. Having examined the water formed from melted snows on glaciers in different parts of the Alps, and having always found it of the same quality, I shall consider it as pure water, and describe its characters.

Its colour, when it has any depth, or when a mass of it is seen through, is bright blue; and according to its greater or less depth of substance, it has more or less of this colour. Lakes and masses of water on high mountains are of the same bright azure. When vegetables grow in lakes, the colour becomes nearer sea-green; and as the quality of impregnation from their decay increases, greener, yellowish-green, and at length, when the vegetable extract is large in quantity—as in countries where peat is found—yellow, and even brown. To mention instances, the Lake of Geneva, fed from sources (particularly the higher Rhone) formed from melting snow, is blue; and the Rhone pours from it dyed of the deepest azure, and retains partially this colour till it is joined by the Saone, which gives to it a greenish hue. The Lake of Morat, on the contrary, which is fed from a lower country, and from less pure sources, is grass-green. And there is an illustrative instance in some small lakes fed from the same source on the road from Innspruck to Stuttgart, between Nazareit and Reiti. The highest lake fed by melted snows, in March, when I saw it, was bright blue. It discharged itself by a small stream into another, into which a number of large pines had been blown by a winter storm, or had fallen from some other cause: in this lake its colour was blue green. In a third lake, in which there were not

only pines and their branches, but likewise other decaying vegetable matters, it had a tint of faded grass-green; and these changes occurred in a space not much more than a mile in length.

These observations I made in 1815. On returning to the same spot twelve years after, in August and September, I found the character of the lakes entirely changed. The pine wood washed into the second lake had entirely disappeared; a large quantity of stones and gravel, washed down by torrents, or detached by an avalanche, supplied its place. There was no perceptible difference of tint in the two upper lakes; but the lowest one, where there was still some vegetable matter, seemed to possess a green hue. The same principle will apply to the Scotch and Irish rivers, which, when they rise or issue from pure, rocky sources, are blue, or bluish-green; and when fed from peat-bogs or alluvial districts, yellow, or amber-coloured, or brown, even after they have deposited a part of their impurities in great lakes. Sometimes, though rarely, mineral impregnations give colour to water; small streams are sometimes green or yellow from ferruginous depositions. Calcareous matters seldom affect their colour, but often their transparency, when deposited—as is the case with the Velino at Terni, and the Anio at Tivoli; but I doubt if purely saline matters, which are in themselves white, ever change the tint of water.

As to the "sea-green" colour of the ocean, I think this depends probably on vegetable matter, and perhaps partially on two elementary principles—iodine and bromine—which it certainly contains, though these are possibly the result of decayed marine vegetables. These give a yellow tint when dissolved in minute portions in water; and this, mixed with the blue of pure water, would occasion *sea-green.* I made, many years ago—being on the *Mer-de-Glace*—an experiment on this subject. I threw a small quantity of iodine—a substance then recently discovered—into one of those deep blue basins of water which are so frequent on that glacier, and, diffusing it as it dissolved with a stick, I saw the water change first to sea-green in colour, then to grass-green, and lastly to yellowish-green. I do not, however, give

this as a proof, but only as a fact favourable to my conjecture.—Sir Humphry Davy's *Salmonia.*

MOUNTAIN TONES.

When treading the passes and climbing the buttresses of the Upper Pyrenees, I have frequently heard that peculiar moaning sound which has been noted by other wanderers among mountains, and this where there were no waterfalls, no foaming stream, no current of the atmosphere, nor indeed anything in motion that I could see to account for the strange murmurs that rose and fell on the ear. Noises among mountains are so common as generally to merit little or no attention. In fact the air in elevated mountain ranges is so rarely still, that gorges and defiles are like Prospero's island—

> ——"full of noises;
> Sounds and sweet airs, that give delight and hurt not."

But I now allude more particularly to a peculiar humming tone, occasionally heard when the air is perfectly calm, as if the strings of a gigantic Eolian harp, hanging high among the peaks, were swept by winds unfelt below.

Conversing on this subject with a friend, my attention was directed to an interesting paper in the eighth volume of the *Edinburgh Philosophical Journal*, "On Peculiar Noises occasionally Heard in Particular Districts," where the anonymous author states that he heard such sounds proceeding from the Maladetta. He left Luchon with a friend for the Port de Venasque, and when there, he says, "We were most forcibly struck with a dull, low, murmuring sound, which alone broke upon the deathly silence, evidently proceeding from the Maladetta mountain, though we in vain attempted to connect it with any particular spot, or assign any adequate cause for the solemn strains. The air was perfectly calm, the sky was cloudless, and the atmosphere clear to that extraordinary degree conceivable only by those familiar with the elevated regions of southern climates;—so clear and pure, indeed, that at noon a bright star, which had attracted no notice through-

out the gray of the morning, still remained visible in the zenith. By the naked eye, therefore, and still more with the assistance of the telescope, any waterfalls of sufficient magnitude would have been distinguishable as a front base, and exposed before us; but not a stream was to be detected, and the bed of what gave tokens of being occasionally a strong torrent, intersecting the valley at its foot, was then nearly dry. I will not presume to assert that the sun's rays, though at the moment impinging in all their glory on every point and peak of the snowy heights, had any share in vibrating those mountain chords; but on a subsequent visit a few days afterwards, when I went alone to explore this wild scenery, and at the same hour stood on the same spot, I listened in vain for the moaning sounds; the air was equally calm, but the sun was hidden by clouds, and a cap of dense mist hung over the greater portion of the mountain."

When I visited the Port de Venasque a terrific storm swept through the pass, shrieking among the jagged peaks and pinnacles, so that I cannot confirm, by my own experience, the foregoing account of soft moanings proceeding from the Maladetta; but, as I have stated, I have heard similar noises among other mountains besides the Pyrenees. The illustrious Humboldt, in his comprehensive and searching inquiries into natural phenomena, has not omitted these mysterious mountain melodies. He gives an account of the organ-like sounds heard at sunrise, supposed to proceed from granitic rocks on the banks of the Orinoco, and ascribes these and other noises to undulations of the atmosphere, caused by different parts of the Earth's surface being unequally heated. How a slight cause produces, under favourable acoustical circumstances, considerable noise, is well known, though imperfectly understood. We have a remarkable instance of this in the loud noise produced by the sand, when set in motion at Nakuh, on Mount Sinai. Professor Ehrenberg visited this hill for the express purpose of ascertaining the cause of the sound, and after a long and patient investigation came to the conclusion that the motion of the sand was the cause. "Every step he and his companion took caused a partial sound, occasioned by the sand thus

set in motion. Beginning with a soft rustling, it passed gradually into a murmuring, then into a humming noise, and at length into a threatening of such violence that it could only be compared to a distant cannonade, had it been more continued and uniform. As the sand gradually settled again, the noise also gradually ceased."

When we find noise of this great intensity produced by such a cause, and remember the enormous distance that sound travels under favourable conditions of the atmosphere, we can easily understand why we hear noises among mountains during a still day, even while we know that the cause may be very distant. The fall, for example, of snow in the lofty heights of some far-off mountain, which is heard in thunder tones by the spectator, may occasion undulations in the atmosphere which, travelling through many folds of hills and mountains, fall on our ear, when we are miles from the avalanche, like soft moanings. Occasionally, however, through ignorance of the cause, mountain sounds are extremely perplexing; though many of them undoubtedly arise from distant noises carried by reverberation, from atmospheric currents caused by unequal heating of the surface, from similar currents streaming through gorges and intensified by echo, and those most audible, of course, during still, sunny, and serene states of the lower atmosphere.—*Adapted from* WELD'S *Pyrenees.*

ASPECTS OF THE SEA.

THE surface of the ocean is not the monotonous plain which some would make it out to be; it is ever varying with a succession of aspects both of form and colour. Now it is smooth and glassy; now breaking into dimpled smiles, the **ἀνηριθμον γελασμα** of the dramatist;—now capped with foam and breaking all around into *white horses;* and now rolling in majestic billows, which I for one never tire of watching, as they bound along from afar off as though they meant to engulf the ship, and then raising her gently up to their highest crest, poise her above the boiling

plain, and as gently lower her again into a smooth hollow valley, the emerald sides of which are streaked with foam. The sudden and rapid changes, and the ever-varying prospect, form as near an approach to the wavy, skimming flight of a sea-bird as can well be imagined.

Nor is the colour of the sea more monotonous than its other aspects. Now a pale sapphire blue, it deepens into ultramarine, and then again into intense indigo, or blue-black. Again it may assume a pale yellow-green colour, and become bright emerald; and when the setting sun bathes the clouds with gold, the sea partakes of their glory, and dazzles the eye with a flood of light, which fades away like the dying hues of the dolphin through shades of purple and rose, until it once more assumes its twilight tint of deep indigo-blue.

The natural colour of the deep sea when perfectly at rest, in fine weather, is a rich violet-blue, of an intensity and indescribable brilliancy which no pigment ever equalled. Nor is this colour in any degree dependent upon the blueness of the sky in the way of reflection, which not only does not cause, but in no way assists in intensifying the blue of the sea. For not only is this colour of the sea to be observed when the sky is cloudless, but also when, although bright, scarcely any blue sky is visible, the whole vault being filled with rolling *white* cumuli. But anything which intercepts the light of the sun changes at once this rich violet-blue into some other colour. If it is a passing cloud, or the shadow of the ship, while all around is bright, the sea becomes under its influence indigo-blue; whereas if direct light is altogether excluded, as on a dull, cloudy day, the sea becomes of a deep blue-black, or even of a leaden hue. Thus I have seen it of a lead-colour and of a bright blue within a space of two hours, when the weather has changed from dull to fine. The same effect is also produced when the sun gets low, although it may be clear.

Near the shore, or in soundings, as it is expressed, the sea is never of this rich violet-blue, probably because the depth of the water is not sufficient for the light to have its full and true effect.

Moreover, the sea being beautifully clear and transparent, at a moderate depth the nature of the bottom has a perceptible effect upon the colour of the water. Usually under such circumstances the colour of the sea is olive-green, a colour which I have observed extending for seventy or eighty miles from land off the south coast of Africa; and nearer than this, when the water is shallow, it often has a variegated appearance, directly due to the various growths of weed and the irregularities of the sea-bed.

But even in deep-sea the water is not always violet-blue or indigo; for under the same conditions of light, the smoothness or roughness of the surface is accompanied by gradations of colour between blue and yellow. Thus on a fine day, such as, if also smooth, would have produced the characteristic violet-blue, the surface being ruffled, a fine *light*-blue tint was everywhere visible, but more usually a shade of green;—a circumstance which was particularly marked when, after squally weather, we were in a latitude in which the soundings marked in the chart were 2350 fathoms, but the sea was of a light-green colour; and the remark I have entered in my journal was, that " for some two or three days past, during windy weather, the sea has lost its blue colour, and to-day seems *washed out.* This peculiar phenomenon I attribute to the commotion which the sea has undergone, having entangled air with the water; and although no masses of foam are anywhere visible, myriads of minute air bubbles, mingled with the water, modify the usual absorption of light, and reflect more or less of the yellow rays." That this is the proper explanation, is confirmed by a fact I have more than once noticed; namely, that when, in fine weather, the sea has been of the ordinary dark-blue colour, the wake of the ship has been marked by a path of light-green water for a long distance behind.

That blue is the natural colour of the water is moreover proved by the fact, that whatever the colour of the sea under the changing influences of light and shade, whether dull and leaden or bluish-green, the water in the screw-well—upon which we look directly down, and which is liable to no lateral reflection

or disturbing influences such as the open sea must of necessity be subject to from the angle at which our eyes regard it—is always *blue*, sometimes pale, sometimes dark, but, under the most favourable circumstances, of an intensity which frequently attracts the admiration of those to whom it is an everyday occurrence. I think it was Sir Humphry Davy who attributed this blueness of the sea to the presence of *iodine;* but I cannot help thinking that it is an inherent property in the water, just as some shade of the same colour appears to be an inherent property in the air of the atmosphere—that is to say, that sea-water, as such, in sufficient quantity, absorbs the red and yellow with their compounds, rejecting the blue and violet for the benefit of our eyes.—COLLINGWOOD'S *Naturalist's Rambles in the Chinese Seas.*

THE CIRCULATION OF WATER.

THE simplest form of the circulation of matter is that which is presented by the watery vapour contained in the atmosphere. From this vapour the dews and rains are formed which refresh the scorched plant and fertilize the earth. The depth of dew which falls we cannot estimate. On summer evenings it appears in hazy mists, and collects on leaf and twig in sparkling pearls; but at early dawn it vanishes again unmeasured—partly sucked in by plant and soil, and partly dispelled by the youngest sunbeams. But the yearly rain-fall is easily noted. In our island it averages about thirty inches in depth; and in Western Europe generally, it is seldom less than twenty inches. Among our Cumberland mountains in some places a fall of two hundred inches a year is not uncommon; while among the hills near Calcutta as much as five hundred and fifty inches sometimes fall within six months.

Now, as the whole of the watery vapour in the air, were it to fall at once in the form of rain, would not cover the entire surface of the Earth to a depth of more than five inches, how repeated must the rise and fall of this watery vapour be! To keep

the air always duly moist, and yet to maintain the constant and necessary descent of dew and rain, the invisible rush of water upwards must be both great and constant. The ascent of water in this invisible form is often immediate and obvious, depending solely upon physical causes; but it is often also indirect, and being the result of chemical or physiological causes, is less generally perceptible. Thus—

1. Water circulates abundantly between earth and air through the agency of purely physical causes. We see this when a summer shower falling upon our paved streets is speedily licked up again by the balmy winds, and wafted towards the region of clouds, ready for a new fall. But on the greatest scale this form of circulation takes place from the surface of the sea in equatorial regions, heated through the influence of the sun's rays. Thence streams of vapour are continually mounting upwards with the currents of ascending air, and with these they travel north and south till colder climates precipitate them in dew, rain, or snow. Returned to the arctic or temperate seas by many running streams, these precipitated waters are carried back again to the equator by those great sea-rivers which mysteriously traverse all oceans; and, when there, are ready to rise again to repeat the same revolution. How often, since time began, may the waters which cover the whole Earth have thus traversed air and sea, taking part in the endless movements of inanimate nature!

2. Again: physiological causes, though in a less degree than the physical, are still very largely influential in causing this watery circulation. Thus the dew and rain which fall sink in part into the soil, and are thence drunk in by the roots of growing plants. But these plants spread out their green leaves into the dry air, and from numberless pores are continually exhaling watery vapour in an invisible form. From the leafy surface of a single acre in crop, it is calculated that from three to five millions of pounds of water are yearly exhaled in the form of vapour in our island; while, on an average, not more than two and a half millions fall in rain. Whether the surplus thus given off be derived from dews or from springs, it is plain that

this evaporation from the leaves of plants is one of the more important forms which the circulation of water assumes. So animals take into their stomachs another portion of the same water, and, as a necessary function of life, are continually returning it into the air from their lungs and their insensibly reeking hides. About two pounds a day are thus discharged into the air by a full-grown man; and larger animals give off more, probably, in proportion to their size. Multiply this quantity by the number of animals which occupy the land surface of the globe, and the sum will show that this also is a form of watery circulation which, though less in absolute amount than the others I have mentioned, is yet of much importance in the economy of nature.

3. But water circulates also, in consequence of unceasing chemical operations, in a way which, if less obvious to the uninstructed, is, if possible, more beautiful and more interesting than the mere physical methods above described. We have seen that the main substance of plants—their woody fibre—consists in large proportion of water. The same is true of the starch and sugar which are consumed by an animal. When the plant dies and decomposes in the air, the water is again set free from its woody stem. Or when the animal digests the starch and sugar, the water which these contain is discharged from its lungs and skin. Thus the living plant works up water into its growing substance, which water the decaying plant and the breathing animal again set free; and thus a chemical circulation continually goes on, by which the same water is caused again and again to revolve. Within a single hour it may be in the form of starch in my hand, be discharged as watery vapour from my lungs, and be again absorbed by the thirsty leaf to add to the substance of a new plant.—JOHNSTON: *Chemistry of Common Life.*

DEW: ITS NATURE AND ORIGIN.

How beautiful is the morning dew, glittering in all the colours of the rainbow; how it refreshes the thirsty plains; how the plants raise their drooping heads under the influence of its grateful moisture! Poets have made it the emblem of purity; but physical science, by revealing to us the simple laws that preside over its formation, has rendered it more beautiful still to the reflecting observer.

Everybody knows that when, in summer, a bottle filled with cold water is brought into a warm room it soon gets thickly covered with dew-drops, which presently trickle down its sides, although it was perfectly dry on entering. Whence does this moisture proceed? Not from the inside of the bottle, as ignorant people might imagine, but from the surrounding atmosphere, in consequence of the capacity of the air to absorb or retain moisture increasing or diminishing as its temperature grows warmer or colder. Thus, when the cold bottle is introduced into the room, the warm sheet of air which is in immediate contact with its surface immediately cools; and being no longer able to retain the same quantity of aqueous vapours, is obliged to deposit them on the sides of the vessel. As it cools, its weight also increases; it flows downwards; warmer air takes its place, to cool in its turn; and thus there is a perpetual deposition of moisture, until the temperature of the bottle has risen to that of the surrounding atmosphere.

This familiar example suffices to explain the formation of dew and of all other atmospherical precipitations, such as rain, hail, and snow, as they all result from the influence of some refrigerating cause upon the air. After sunset most bodies, by projecting or radiating heat into free space, become colder than the neighbouring air; and as soon as their refrigeration has attained a certain point they must naturally, in consequence of the physical law above mentioned, get covered with dew. The best radiators part, of course, most easily with their caloric; and for this reason

grass, leaves, and plants in general, get much sooner and more plentifully covered with dew than slow radiators, such as stones, the soil, and metals, which frequently remain dry when the meadows are already covered with plentiful moisture. Hence we can understand why, in summer, every serene night (for clouds, by reflecting or throwing back again upon the terrestrial surface the caloric which would else have been dissipated into space, prevent its rapid refrigeration) is accompanied with a copious formation of dew; why it is more abundant in autumn and spring than at any other season, as then very cold and starlight nights frequently follow upon warm days; and why it is most copious in the torrid zone, as in those sultry regions the air is more saturated with moisture than anywhere else, and the comparatively cold nights are almost constantly serene and calm.

Had naked stones been as good radiators of heat as leaves and herbs, then the latter would vainly have thirsted for refreshment, while the former would have been bathed in useless moisture. Had the dew been plentiful during violent winds, the plants must frequently have suffered, or been frozen to death in consequence of the rapid evaporation of their moisture. Where the sun has most power, where during the day he most thoroughly dries up the soil, there also the cool night is most prodigal of dew. Thus the history of dew gives us many opportunities of admiring the wisdom that has presided over its formation and distribution.—HARTWIG'S *Harmonies of Nature.*

THE GARUA, OR SEA-FOGS OF PERU.

GARUA is the native term for those dense sea-fogs which occur periodically (from June to November) along the Pacific coast of South America. During the garua, it is said, the atmosphere loses its transparency, and the sun is obscured for months together. The vapours of the garua of Lima are so thick that the sun, seen through them with the naked eye, assumes the appearance of the moon's disc; or, according to Dr. Scherzer, they are

"so dense that it is quite possible to count each separate drop." They commence in the morning, and extend over the plains in the form of refreshing fogs, which disappear soon after midday, and are followed by heavy dews, which are precipitated during the night. The subjoined account of these curious sea-mists is gleaned from Dr. Tschudi's *Travels in Peru* :—

"In November summer commences. The rays of the sun are refracted on the light-gray sandy carpet, and are reflected with scorching power. Every living thing which does not quickly escape from their influence is devoted to certain destruction. No plant takes root in the burning soil; and no animal finds food on the arid, lifeless surface. No bird, no insect, moves in the burning atmosphere. Only in the very loftiest regions the king of the air, the majestic condor, may be seen floating, with daring wing, on his way to the sea-coast.

"The scene changes in May. A thin veil of mist then overspreads the sea and the shore. In the following months the thickness of the mist increases, and it is only in October that it begins to disperse. In the beginning and at the end of the period called winter this mist commonly rises between nine and ten o'clock in the morning, and disappears about three in the afternoon. It is heaviest in August and September; and it then lies for weeks immovable on the earth. It does not resolve into what may be properly called rain, but it becomes a fine, minute precipitate, which the natives call *garua* (thick fog, or drizzling rain). Many travellers have alleged that there are places on the Peruvian coast which have been without rain for centuries. This assertion is to a certain extent correct; for there are many districts in which there never is rain except after an earthquake, and not always even then. Though the garua sometimes falls in large drops, still there is this distinction between it and rain, that it descends, not from clouds at a great height, but is formed in the lower atmosphere by the union of small vesicles of mist. The average perpendicular height over which this fog passes does not exceed one thousand two hundred feet; its medium boundary being from seven to eight hundred feet. That it is known only

within a few miles of the sea is a highly curious phenomenon. Beyond these few miles it is superseded by heavy rains; and the boundary line between the rain and the mist may be defined with mathematical precision. I know two plantations, the one six leagues from Lima, the other in the neighbourhood of Huacho; one half of these lands is watered by the garuas, the other half by rain, and the boundary line is marked by a wall!

"When the mists set in, the chain of hillocks (*lomas*) bordering the sand-flats on the coast undergoes a complete change. As if by stroke of magic, blooming vegetation overspreads the soil, which a few days previously was a mere barren wilderness. Horses and cattle are driven into these parts for grazing, and during several months the animals find abundance of rich pasture. There is, however, no water; but they do not appear to suffer from the want of it, for they are always in a good healthy condition on leaving the lomas.

"In some parts of Northern Peru, where the garuas are scanty, the fertility of the soil depends wholly on the mountain rains, for in summer most of the rivers are dried up. When there is a deficiency of rain the cattle on the coast suffer greatly. At Piura there is such a total absence of dew, that a sheet of paper left for a whole night in the open air does not, in the morning, exhibit the smallest trace of humidity. In Central and South Peru the moisture scarcely penetrates half an inch into the soil. In the oases the garuas are much heavier than in the adjacent wastes, the vegetation tending to condense it. Along the whole of the coast there is no rain, and no vegetation throughout a large circuit save that which is periodically nourished by the garua."

THE SNOW BLANKET.

THE "snow blanket" is the name given by farmers and others to any considerable thickness of snow which covers the ground during winter, and helps to protect its vegetation from the severity of the frost. In continental countries, like Central and

Northern Europe, this covering is of essential service during severe and long-continued frosts in early spring; and in Russia it is common to predict the abundance of the ensuing harvest from the thickness of the snow blanket—a great thickness protecting the young shoots of the grain plants, while an insufficient covering exposes them to the destructive effects of the cold. It is in the high latitudes of the extreme north, however, where its influence is most felt and appreciated. "Few of us at home," says Dr. Kane, in his *Arctic Explorations*, can realize the protecting value of this warm coverlet of snow. No eider-down in the cradle of an infant is tucked in more kindly than the sleeping dress of winter about this feeble flower-life. The first warm snows of August and September, falling on a thick carpet of bleached grasses, heaths, and willows, enshrine the flowery growths which nestle round them in a non-conducting air-chamber; and as each successive snow increases the thickness of the cover, we have, before the intense cold of winter sets in, a light cellular bed, covered by drift six, eight, or ten feet deep, in which the plant retains its vitality. The frozen subsoil does not encroach upon this narrow cover of vegetation. I have found in mid-winter, in this high latitude of 78° 50′, the surface so nearly moist as to be friable to the touch; and upon the ice-floes, commencing with a surface temperature of $-80°$, I found at two feet deep a temperature of $-8°$, at four feet $+9°$, and at eight feet $+26°$! My experiments prove that the conducting power of the snow is proportioned to its compression by winds, rains, drifts, and congelation. The early spring and late fall and summer snows are more cellular and less condensed than the nearly impalpable powder of winter. The drifts, therefore, that accumulate during nine months of the year are dispersed in well-defined layers of differing density. We have first the warm cellular snows of fall, which surround the plant; next, the fine impacted snow-dust of winter; and above these, the later humid deposits of the spring. It is interesting to observe the effects of this disposition of layers upon the safety of the vegetable growths beneath them. These, at least in the earlier summer, occupy the inclined slopes that face the

sun, and the several strata of snow take of course the same inclination. The consequence is, that as the upper snow is dissipated by the early thawing, and sinks upon the more compact layer below, it is to a great extent arrested, and runs off like rain from a slope of clay. The plant reposes thus in its cellular bed from the rush of waters, and is protected too from the nightly frosts by the icy roof above it."

EFFECTS OF FOREST GROWTH ON CLIMATE.

Much of the effect wrought by high mountains on the moisture of the air may be secured to the plains by careful attention to the forests. Forests are the natural gatherers of the moisture from the air. By the loosening which they give to the soil, by the plentiful undergrowth of herbage which thrives beneath their shelter, they hinder the rain water, even on sloping ground, from quickly running off. They everywhere check the currents of air, and thus retard the carrying off of the moisture by drying winds. Under their leafy shade the heat of the summer is assuaged, and the few sun-rays that find their way to the soil can lick up but little of the moisture for the warm currents to carry to the upper air. Again: because the water sucked up from the earth by the roots is breathed out again by the twigs and leaves as vapour, the air in the forests always remains moister and nearer to the dew-point than it does where the land is not wooded. While, therefore, the warm air is mounting up from the dry soil of the open country, the chilled and moister air must fall again from above upon the cooler surface of the woodland. Thus all the conditions necessary for the fall of moisture from the air meet in much greater force about the forests than over the open country.

When the south wind charged with vapour blows over dry ground heated by the sun, no fall of wet can easily take place; but rather, the clouds that are ready formed, sinking down into the warmer layers of air below, are dissolved again and vanish. The parched, warm soil, drives the rain away from itself. But

where the temperature is softened down by woods, and where the air, besides, is loaded with moisture by the constant evaporation, it will soon be overcharged by the falling clouds, and rain will follow. We are therefore right in commonly saying that the woods fetch down the rain, just as we are in saying that it is drawn to mountains and broad rivers. True it is, too, that the clouds cling to the forests as they do to the mountains, since the cool and moist air which floats over the woods favours their formation; when, however, the resulting clouds, driven by the wind beyond the forest, reach the warm air rising up from a dry soil, they are again dissolved into invisible vapour.

On the other hand, we find that over single woodless islands in the sea the sky remains cloudless, while all around thick clouds may be gathered; because the current, mounting up from the ground heated by the sun's rays, raises for a time the capacity for vapour in the higher layers of the air. The Canary Isles, when they were discovered, were clothed with thick forests, and overgrown with the richest verdure. Great part of those woods were destroyed and burned by the first settlers: the result has been the lessening of their rains, and the dwindling away of their springs and brooks.

Thus the rooting up, or even the mere thinning, of forests always exerts a striking influence on the moisture of a country. Many districts which in former times were known for their rich fruitfulness, have lost, together with their forests, much of their flourishing condition, and have even been changed, in part, into desert. But you will also see that, by gradually planting trees, many regions of our Earth, which have been hitherto waste and barren, may be rendered fit for tillage and the dwelling of man.—BUFF: *Physics of the Earth.*

THE TRADE WINDS.

IT is a matter of observed fact that the sun is constantly vertical over some one or other part of the Earth between two parallels of latitude, called the *Tropics*, respectively $23\frac{1}{2}^{\circ}$ north and as much

south of the equator; and that the whole of that zone or belt of the Earth's surface included between the tropics, and equally divided by the equator, is, in consequence of the great altitude attained by the sun in its diurnal course, maintained at a much higher temperature than those regions to the north and south which lie nearer the poles. Now, the heat thus acquired by the Earth's surface is communicated to the incumbent air, which is thereby expanded, and rendered specifically lighter than the air incumbent on the rest of the globe. It is therefore, in obedience to the general laws of hydrostatics, displaced and buoyed up from the surface, and its place occupied by colder, and therefore heavier air, which glides in on both sides along the surface from the regions beyond the tropics; while the displaced air, thus raised above its due level, and unsustained by any lateral pressure, flows over, as it were, and forms an upper current in the contrary direction, or towards the poles; which, being cooled in its course, and also sucked down to supply the deficiency in the extra-tropical regions, keeps up thus a continual circulation.

Since the Earth revolves about an axis passing through the poles, the equatorial portion of its surface has the greatest velocity of rotation, and all other parts less in the proportion of the radii of the circles of latitude to which they correspond. But as the air, when relatively and apparently at rest on any part of the Earth's surface, is only so because in reality it participates in the motion of rotation proper to that part, it follows that when a mass of air near the poles is transferred to the region near the equator by an impulse urging it directly towards that circle, in every point of its progress towards its new situation it must be found deficient in rotatory velocity, and therefore unable to keep up with the speed of the new surface over which it is brought. Hence the currents of air which set in towards the equator from the north and the south must, as they glide along the surface, at the same time lag or hang back, and *drag upon* it in the direction *opposite* to the Earth's rotation—*i.e.*, from east to west. Thus these currents, which but for the rotation would be simply northerly and southerly winds, acquire from this cause a *relative*

direction towards the west, and assume the character of permanent north-easterly and south-easterly winds.

Were any considerable mass of air to be *suddenly* transferred from beyond the tropics to the equator, the difference of the rotatory velocities proper to the two situations would be so great as to produce not merely a wind, but a tempest of the most destructive violence. But this is not the case: the advance of the air from the north and the south is gradual, and all the while the Earth is continually acting on, and by the friction of its surface accelerating its rotatory velocity. Supposing its progress towards the equator to cease at any point, this cause would almost immediately communicate to it the deficient motion of rotation, after which it would revolve quietly with the Earth, and be at relative rest. We have only to call to mind the comparative *thinness* of the coating which the atmosphere forms around the globe, and the immense *mass* of the latter compared with the former (which it exceeds at least 100,000,000 times), to appreciate the absolute *command* of any extensive territory of the Earth over the atmosphere immediately incumbent on it, in point of motion.

It follows from this, then, that as the winds on both sides approach the equator their easterly tendency must diminish. The lengths of the diurnal circles increase very slowly in the immediate vicinity of the equator, and for several degrees on each side of it hardly change at all. Thus the friction of the surface has more time to act in accelerating the velocity of the air, bringing it towards a state of *relative* rest, and diminishing thereby the relative set of the currents from east to west; which, on the other hand, is feebly, and at length not at all, reinforced by the cause which originally produced it. Arrived, then, at the equator, the *trades* must be expected to lose their easterly character altogether. But not only this, the northern and southern currents, here meeting and opposing, will mutually destroy each other, leaving only such preponderancy as may be due to a difference of local causes acting in the two hemispheres, which in regions around the equator may in some places lie one way, in some another.

The result, then, must be the production of two great tropical belts, in the northern of which a constant *north-easterly*, and in the southern a *south-easterly* wind must prevail, while the winds in the equatorial belt, which separates the two former, should be comparatively calm and free from any steady prevalence of easterly character. All these consequences are agreeable to observed fact, and the system of aërial currents above described constitutes in reality what is understood by the regular *trade winds.*—HERSCHEL'S *Outlines of Astronomy.*

THE MONSOONS.

THE winds of the Indian Ocean experience still greater perturbations than those of the other two oceans of the tropics. If I have elsewhere called the Pacific the most *oceanic* of the oceans, the Atlantic the most *maritime*, I will call the Indian Ocean the most *mediterranean.* It is, in reality, only half an ocean, a great gulf, surrounded on three sides by huge continental masses: the mighty Asia, with its peninsulas and its table-lands on the north; Africa on the west; Australia on the east. Asia prevents the oceanic trade-wind of the north-east from arriving there, and the influence of the lands and the vast plateaus remains greatly preponderating. Thus the movements of the atmosphere depend upon the unequal heating of the neighbouring continents during the extreme seasons of summer and winter, which are opposite in the continents situated in the north and in the south. The eastern trade wind in this way changes into a sort of double semi-annual breeze, blowing regularly six months in one direction, and six months in another;—this is called *monsoon*, from the Arabic word *moussin*, signifying season. It will be easy to understand this effect, if you call to mind what we have said of the land and sea breezes that spring up on the islands and along the shores; that is, the sea breeze blowing toward the land when the air over the land has been heated during the day, and the land

breeze blowing toward the sea when the air over the land has been more rapidly cooled down by night radiation.

While Africa south of the equator receives the vertical rays of the southern summer sun in December, January, and February, Southern Asia and neighbouring seas on the north of the equator are feeling the low temperature of winter. The air rushes in from the colder regions of the Indies and of Upper Asia towards the warmer regions of Southern Africa, and the trade wind is transformed into a north-easter, which blows as long as this difference of temperature lasts. It is for India the winter or north-east monsoon. The reverse takes place when India and Southern Asia are heated by the burning sun of the northern summer, and when Africa is cooled by the southern winter. The air blows towards the places of which the temperature is more elevated: it is for India the summer or south-west monsoon.

Hence, in place of a constant current setting from east to west, the relative position of the lands combined with the action of the Earth's rotation gives occasion to two periodical winds; the monsoon of the south-west, blowing from April till October during the northern summer; and the north-east monsoon, blowing from October till April during the southern summer. In the southern part of the Indian Ocean, which is not under the influence of the lands, the south-east trade wind blows quite regularly throughout the whole year. The transition from one monsoon to another, depending upon the course of the sun, does not occur at the same period in places situated under different latitudes; but the approach of this critical season is always announced by variable winds, succeeded by intervals of calm, and by furious tempests and whirlwinds, proving a general disturbance of the atmosphere.

The phenomenon of the monsoon, or the change of winds according to the seasons, takes place in like manner between the Indies and New Holland; but it is less regular and less marked than the Indo-African system we have just described. The seas of Southern China and the great Archipelago of Sunda and the Moluccas, by their position, feeling at the same time the influence of the trade wind of the great ocean and of the double

system of the monsoons of the Indies and Australia, it is easily conceived that we must seek in this circumstance the cause of the tempests and typhoons which desolate those seas more than any other upon the surface of the globe.—GUYOT'S *Earth and Man.*

THE SOUTH-WEST MONSOON IN CEYLON.

MAY is signalized by the great event of the change of the monsoon, and all the grand phenomena which accompany its approach. It is difficult for one who has not resided in the tropics to comprehend the feeling of enjoyment which accompanies these periodical commotions of the atmosphere. In Europe they would be fraught with annoyance, but in Ceylon they are welcomed with a relish proportionate to the monotony they dispel.

Long before the wished-for period arrives, the verdure produced by the previous rains becomes almost obliterated by the burning droughts of March and April. The deciduous trees shed their foliage, the plants cease to put forth fresh leaves, and all vegetable life languishes under the unwholesome heat. The grass withers on the baked and cloven earth, and red dust settles on the branches and thirsty brushwood. The insects, deprived of their accustomed food, disappear under ground, or hide beneath the decaying bark; the water-beetles bury themselves in the hardened mud of the pools; and the snails retire into the crevices of the stones or the hollows among the roots of the trees, closing the aperture of their shells with the hibernating epiphragm. Butterflies are no longer seen hovering over the flowers; the birds appear fewer and less joyous; and the wild animals and crocodiles, driven by the drought from their accustomed retreats, wander through the jungle, or even venture to approach the village wells in search of water. Man equally languishes under the general exhaustion, ordinary exertion becomes distasteful, and the native Singalese, although inured to the climate, move with lassitude and reluctance.

Meanwhile the air becomes loaded to saturation with aqueous

vapour, drawn up by the augmented force of evaporation acting vigorously over land and sea: the sky, instead of its brilliant blue, assumes the sullen tint of lead; and not a breath disturbs the motionless rest of the clouds that hang on the lower range of the hills. At length, generally about the middle of the month, but frequently earlier, the sultry suspense is broken by the arrival of the wished-for change. The sun has by this time nearly attained his greatest northern declination, and created a torrid heat throughout the lands of Southern Asia and the Peninsula of India. The air, lightened by its high temperature and such watery vapour as it may contain, rises into loftier regions, and is replaced by in-draughts from the neighbouring sea; and thus a tendency is gradually given to the formation of a current bringing up from the south the warm humid air of the equator. The wind, therefore, which reaches Ceylon comes laden with moisture, taken up in its passage across the great Indian Ocean. As the monsoon draws near, the days become more overcast and hot, banks of clouds rise over the ocean to the west, and in the twilight the eye is attracted by the peculiar whiteness of the sea-birds that sweep along the strand to seize the objects flung on shore by the rising surf.

At last the sudden lightnings flash among the hills and sheet among the clouds that overhang the sea, and with a crash of thunder the monsoon bursts over the thirsty land, not in showers or partial torrents, but in a wide deluge, that in the course of a few hours overtops the river banks and spreads in inundations over every level plain. The rain at these periods excites the astonishment of a European. It descends in almost continuous streams, so close and dense that the level ground, unable to absorb it sufficiently fast, is covered with one uniform sheet of water; and down the sides of declivities it rushes in a volume that wears channels in the surface. For hours together, the noise of the torrent, as it beats upon the trees and bursts upon the roofs, flowing thence in rivulets along the ground, occasions an uproar that drowns the ordinary voice, and renders sleep impossible.

This violence, however, seldom lasts more than an hour or two,

and gradually abates after intermittent paroxysms, and a serenely clear sky supervenes. For some days heavy showers continue to fall at intervals in the forenoon; and the evenings which follow are embellished by sunsets of the most gorgeous splendour, lighting the fragments of clouds that survive the recent storm.

The extreme heat of the previous month becomes modified in June; the winds continue steadily to blow from the south-west, and frequent showers, accompanied by lightning and thunder, serve still further to diffuse coolness throughout the atmosphere and verdure over the earth. So instantaneous is the response of Nature to the influence of returning moisture, that in a single day, and almost between sunset and dawn, the green line of reviving vegetation begins to tint the saturated ground. In ponds from which but a week before the wind blew clouds of sandy dust, the peasantry are now to be seen catching the re-animated fish; and tank-shells and water-beetles revive and wander over the submerged sedges. The electricity of the air stimulates the vegetation of the trees; and scarcely a week will elapse till the plants are covered with the larvæ of butterflies, the forest murmuring with the hum of insects, and the air harmonious with the voice of birds.—*Abridged from* TENNENT'S *Ceylon.*

THE SIROCCO.

ONE of the most annoying visitors of Sicily and the regions around is the *Sirocco*, or South-easter, a wind detested equally by ancients and moderns; being, no doubt, the "evil vapour" of Homer into which Mars retreated when wounded by Minerva. This debilitating breeze, sweeping over the parched deserts of Arabia and Africa, where the hottest summer climate in the world is to be found, is moderated by its passage over the sea to a tolerable degree of temperature; and on the east coast of Sicily, where it first arrives, its effects are inconsiderable, but seeming to acquire additional heat in its progress over the land, becomes a serious inconvenience as it advances. At its commencement

the air is dense and hazy, with long white clouds settling a little below the summits of the mountains, and at sea floating just above the horizon, in a direction parallel to it: it often terminates by a rapid lull, which is succeeded by a north-west breeze. The thermometer does not, at first, experience any very sensible change, though it slowly rises with the continuance of the sirocco to 90° and 95°, which last is the highest I have observed, though the feelings (which are certainly a very inaccurate measure of actual heat) seem to indicate a much higher temperature. The hygrometer shows increased atmospheric humidity, and the barometer gradually sinks to about 29·60 inches. This wind generally continues three or four days; during which period, such is its influence that wine cannot be well fined, or meat effectually salted. Oil-paint laid on while it continues will seldom take or harden; and while from seeming dryness it rives unseasoned wood and snaps harp-strings, it makes metals oxidize more readily, mildews clothes, and renders everything clammy. We are told, however, that dough can be raised with half the usual quantity of leaven; and though blighting in its general effects during summer, it has been known to favour the corn harvest and the growth of several useful herbs and plants in winter.

This wind is peculiarly disagreeable at Palermo, although situated in the north-west part of Sicily; but the plain is surrounded on the land side by mountains, which collect the solar rays as if to a focus. Although somewhat inured to the heat of the East and West Indies, and the sands of Arabia and Africa, I always felt, during a sirocco here, more incommoded by an oppressive dejection and lassitude than in those countries; and it matters little to the person attacked whether the sensation is attributable to the immediate parching of the skin and the absorption of his electricity, or to a peculiar increase of temperature. At such times the streets of Palermo are silent and deserted; for the natives can scarcely be prevailed upon to move out while it lasts, and they carefully close every window and door of their houses to exclude it. Still the sirocco does not appear to be actually prejudicial to human health; though it is

said that if it be of long continuance wounds are sometimes attacked by erysipelatous inflammation, and it is often troublesome to people of a plethoric habit. It is more frequent in the spring and autumn than in the summer; and in winter possesses no disagreeable qualities, except to invalids.—SMYTH'S *Mediterranean.*

WATERSPOUTS.

IT is not uncommon, especially in and near the middle zone of the Mediterranean, to experience typhoons or whirlwinds, of which some of the most obvious instances are those vorticular columns of sand that occur in the deserts of North Africa. From such currents of air rushing through the atmosphere, and along the surface of the sea, with an impetuous spiral motion, there very frequently result, in the warm months, those extraordinary phenomena somewhat inappropriately named *waterspouts*, since they are owing to a commotion of rarified air only. In round terms, they may be described as trumpet-shaped cones descending from a dense cloud, with the small end downwards, beneath which the surface of the sea becomes agitated and whirled round, and the water, converted into vapour, ascends with a spiral impulse, till a junction is effected with the cone proceeding from the cloud. Frequently, however, they disperse before the union takes place, especially when the action of the winds drives them out of their perpendicular position. There can be little doubt that the Franklinian theory is substantially right, and that, from the vapour being evidently drawn or forced upwards, waterspouts are the consequence of a previous whirlwind. In addition to the operation of wind, atmospheric electricity and its opposite may be also found to exert influence; but Dr. Franklin's argument will here suffice, for the upper air is rarer than at the base, and the siphon itself is mechanically elevated by the centrifugal effect of its own whirling motion.

During the formation of a waterspout the winds around are generally light and variable, with frequent whirling catspaws and

calms; but the weather is heavy, with clouds of small dimensions and flaky, in very slow progression over a deep blue sky. At length one of them enlarges, takes a position, becomes elongated, and sends forth a siphon, which finally reaches and agitates the sea; but the moment of contact is not readily made out, for the effect is manifest in the ebullition on the surface before the extremity of the spout has visibly approached it. The base of the column, which may be from fifty to even a hundred feet in diameter—enclosing a smaller, more transparent, and apparently hollow cylinder—is first seen darkening the agitated area beneath it, as well as a wider circle of deep-blue water around; and afterwards the sea discharges a volume of vapour upwards, with an audibly whizzing noise, into the column of the protuberant cloud above it. The dispersion commences with the vertiginous point, which becomes broken, less defined, and shrinks as it were upwards, the siphon often appearing to be suspended to the cloud for some time afterwards; and though other spouts may be then forming, I never noticed the production of a second one from the same cloud. The duration is from two or three to ten minutes, or even longer; and then dispersion is frequently owing to the springing up of a breeze. Such is the most frequent line of action; but I have also known them to form suddenly in squally weather on the chopping round of the wind, or where two winds met; and they are seen both before and after heavy rains, frequently attended with thunder and lightning.

From the earliest times navigators have always, and very naturally, entertained great apprehensions of this phenomenon—the noted *Prester* of the Greeks, the destroyer of those at sea, and of which Lucretius gives so terrific a description. But though most sailors still believe it to be dreadfully dangerous, and small craft have been known to founder immediately on being struck, in most cases it would probably not be productive of any serious injury to a vessel of any tolerable size; nor do I believe that a well-authenticated disaster occasioned by these waterspouts to a well-formed man-of-war is on record. When they appear to be approaching a ship it is not unusual to fire a gun at them, which

by the concussion of the air may scatter them; but when the experiment is tried at all it should be well done. I have been assured that the vibration caused by firing several guns in a salvo infallibly makes the column separate and dissipate in heavy rain, accompanied by local lightning and hail. This process I never tried; but on one occasion, off Maretimo, a fine columnar one of 1300 or 1600 feet in height, being within a mile, was about to be thus operated upon, when it suddenly passed ahead of us while we were gazing in admiration at the magnificent spectacle. The water which falls on such an occasion is, of course, perfectly fresh; but so instantaneous a chemical process cannot be sufficiently accounted for.—*Abridged from* ADMIRAL SMYTH'S *Mediterranean.*

TELESCOPE AND MICROSCOPE: A CONTRAST.

ABOUT the time of the invention of the Telescope another instrument was formed which laid open a scene no less wonderful, and rewarded the inquisitive spirit of man with a discovery no less important. This was the Microscope. The one led me to see a system in every star; the other leads me to see a world in every atom. The one taught me that this mighty globe, with the whole burden of its people and of its countries, is but a grain of sand on the high field of immensity; the other teaches me that every grain of sand may harbour within it the tribes and families of a busy population. The one told me of the insignificance of the world I tread upon; the other redeems it from all its insignificance, for it tells me that in the leaves of every forest, and in the flowers of every garden, and in the waters of every rivulet there are worlds teeming with life, and numberless as are the glories of the firmament. The one has suggested to me that, beyond and above all that is visible to man, there may be fields of creation which sweep immeasurably along, and carry the impress of the Almighty's hand to the remotest scenes of the universe; the other suggests to me that within and beneath all that minuteness which the aided eye of man has been able to

explore, there may be a region of invisibles; and that could we draw aside the mysterious curtain which shrouds it from our senses, we might there see a theatre of as many wonders as astronomy has unfolded, a universe within the compass of a point so small as to elude all the powers of the microscope, but where the wonder-working God finds room for the exercise of all his attributes, where he can raise another mechanism of worlds, and fill and animate them all with the evidences of his glory.

By the telescope we have discovered that no magnitude, however vast, is beyond the grasp of the Divinity; but by the microscope we have also discovered that no minuteness, however shrunk from the notice of the human eye, is beneath the condescension of his regard. Every addition to the powers of the one instrument extends the limits of his visible dominions; but by every addition to the powers of the other instrument we see each part of them more crowded than before with the wonders of his unwearying hand. The one is constantly widening the circle of his territory; the other is as constantly filling up its separate portions with all that is rich and various and exquisite. In a word, by the one I am told that the Almighty is now at work in regions more distant than geometry has ever measured, and among worlds more manifold than numbers have ever reached; but by the other I am also told, that, with a mind to comprehend the whole in the vast compass of its generality, he has also a mind to concentrate a close and a separate attention on each and on all of its particulars; and that the same God who sends forth an upholding influence among the orbs and the movements of astronomy, can fill the recesses of every single atom with the intimacy of his presence, and travel, in all the greatness of his unimpaired attributes, upon every one spot and corner of the universe he has formed.

They, therefore, who think that God will not put forth such a power, and such a goodness, and such a condescension in behalf of this world as are ascribed to him in the New Testament, because he has so many other worlds to attend to, think of him as a man; they confine their view to the informations of the tele-

scope, and forget altogether the informations of the other instrument. They only find room in their minds for his one attribute of a large and general superintendence, and keep out of their remembrance the equally impressive proofs we have for his other attribute of a minute and multiplied attention to all that diversity of operations where it is he that worketh all in all. And when I think that, as one of the instruments of philosophy has heightened our every impression of the first of these attributes, so another instrument has no less heightened our impression of the second of them, then I can no longer resist the conclusion that it would be a transgression of sound argument, as well as a daring impiety, to draw a limit round the doings of this unsearchable God. And should a professed revelation from Heaven tell me of an act of condescension in behalf of some separate world, so wonderful that angels desire to look into it, and the Eternal Son had to move from his seat of glory to carry it into accomplishment, all I ask is the evidence of such a revelation: for, let it tell me as much as it may of God letting himself down for the benefit of one single province of his dominions. this is no more than what I see lying scattered in numberless examples before me—running through the whole line of my recollections, and meeting me in every walk of observation to which I can betake myself. And, now that the microscope has unveiled the wonders of another region, I see strewed around me, with a profusion which baffles my every attempt to comprehend it, the evidence that there is no one portion of the universe of God too minute for his notice, or too humble for the visitations of his care.—CHALMERS: *Astronomical Discourses.*

ECHOES.

In a district so diversified as this, so full of hollow vales and hanging woods, it is no wonder that echoes should abound. Many we have discovered that return the cry of a pack of dogs, the notes of a hunting horn, a tunable ring of bells, or the melody of

birds, very agreeably; but we were still at a loss for a polysyllabical articulate echo, till a young gentleman, who had parted from his company during a summer evening walk, and was calling after them, stumbled upon a very curious one in a spot where it might least be expected. At first he was much surprised, and could not be persuaded but that he was mocked by some boys; but repeating his trials in several languages, and finding his respondent to be a very adroit polyglot, he then discerned the deception.

This echo, in an evening before rural noises cease, would repeat ten syllables most articulately and distinctly, especially if quick dactyls were chosen. The last syllables of

"Tityre, tu patulæ recubans ——"

were as audibly and intelligibly returned as the first; and there is no doubt, could trial have been made, but that at midnight, when the air is very elastic, and a dead stillness prevails, one or two syllables more might have been obtained; but the distance rendered so late an experiment very inconvenient.

Quick dactyls, we observed, succeeded best; for when we came to try its powers in slow, heavy, embarrassed spondees of the same number of syllables,

"Monstrum horrendum, informe, ingens ——"

we could perceive a return of but four or five.

All echoes have some one place to which they are returned more strongly and distinctly than to any other; and that is always the place that lies at right angles to the object of repercussion, and is not too near, nor too far off. Buildings, or naked rocks, re-echo much more articulately than hanging woods or vales· because in the latter the voice is as it were entangled and embarrassed in the covert, and weakened in the rebound.

The true object of this echo, as we found by various experiments, is the stone-built tiled hop-kiln in Gally Lane, which measures in front 40 feet, and from the ground to the eaves 12 feet. The true *centrum phonicum*, or just distance, is one particular spot in the King's Field, in the path to Norehill, on the very brink of the steep balk above the hollow cart-way. In this

case there is no choice of distance; but the path, by mere contingency, happens to be the lucky, the identical spot, because the ground rises or falls so immediately, if the speaker either retires or advances, that his mouth would at once be above or below the object.

We measured this polysyllabical echo with great exactness, and found the distance to fall very short of Dr. Plot's rule for distant articulation, for the Doctor, in his *History of Oxfordshire*, allows 120 feet for the return of each syllable distinctly; hence this echo, which gives ten distinct syllables, ought to measure 400 yards, or 120 feet to each syllable, whereas our distance is only 258 yards, or nearly 75 feet to each syllable. Thus our measure falls short of the Doctor's as five to eight; but then it must be acknowledged that this candid philosopher was convinced afterwards that some latitude must be admitted of in the distance of echoes according to time and place.

When experiments of this sort are making, it should always be remembered that weather and the time of day have a vast influence on an echo: for a dull, heavy, moist air deadens and clogs the sound; and hot sunshine renders the air thin and weak, and deprives it of all its springiness; and a ruffling wind quite defeats the whole. In a still, clear, dewy evening, the air is most elastic, and perhaps the later the hour the more so.

Echo has always been so amusing to the imagination that the poets have personified her; and in their hands she has been the occasion of many a beautiful fiction. Nor need the gravest man be ashamed to appear taken with such a phenomenon, since it may become the subject of philosophical or mathematical inquiries.

Some time after its discovery this echo became totally silent. Nor was there any mystery in this defect; for the field between was planted as a hop-garden, and the voice of the speaker was totally absorbed and lost among the poles and entangled foliage of the hops. And when the poles were removed in autumn, the disappointment was the same; because a tall quick-set hedge, nurtured for the purpose of shelter to the hop-ground, entirely interrupted the impulse and repercussion of the voice: so that,

till those obstructions are removed, no more of its garrulity can be expected.—WHITE's *Natural History of Selborne.*

LUMINOSITY OF THE OCEAN.

THE cause producing the luminosity of the sea, and its utility in the economy of Nature, have long been the subject of minute attention among naturalists, and the phenomenon has been the admiration of those who have had opportunities of observing it, either during a calm in the tranquil waters of some bay or harbour, or when the waves are breaking and dashing about in masses of luminous matter. It has often been stated to resemble "liquid fire;" but that expression can convey no idea of the reality. It does not assume the glowing brightness of that element, but the effect produced is the white sickly gleam of phosphorus, also displaying a similar deadly and livid greenish hue. At sea the display of luminosity is occasionally very great and extensively diffused; but at other times the gleaming of the phosphorescent matter is in large and distinct patches, as if occasioned by local congregations of the creatures producing it; or it becomes visible only in the broad luminous stream seen in the wake of the passing vessel. During a dark night the gleaming of this peculiar light, illuminating the crests of the waves and flashing as they break under the influence of the breeze, has a striking effect, and cannot fail to excite the admiration of the spectator.

Scientific men are now well aware that the *living* phosphorescent matter is secreted at will, or on excitement, by animals possessing this singular property, for purposes in their economy at present unknown to us. We say *living* luminous matter, in contradistinction to that produced by the decay of fish, floating spawn, and other animal matter by which it is frequently emitted. Such luminosity is not only afforded by a great number of molluscous and crustaceous animals with which the ocean abounds, but has been observed also in a species of shark, and among land-

insects—as the glow-worm, fire-fly, and the luminous centipede. It has also been found in the vegetable kingdom, especially among some of the fungoid or mushroom order. This property, therefore, is common to the vegetable and the animal kingdoms, but much more frequent and intense in the latter, though often emitted by creatures which can be rendered visible only by the aid of the microscope. A distinction ought to be made between luminosity diffused voluntarily by the animals secreting it, and that resulting from the passage of a ship, the rushing of a large fish, or the stroke of an oar; for the former is a gradual and beautiful development of the luminous appearance, while the other is sudden and soon exhausted, though very vivid during the time it remains.

The luminosity of the ocean is said to take place with greatest brilliancy and effect within the Tropics; but it has also been witnessed far beyond these limits, and alike in Arctic and Antarctic waters. It was in the Atlantic, almost under the Equator, late at night, and with fine June weather and a fresh south-easterly breeze, that I was first called upon to witness this appearance. On arriving upon the deck, a broad and extensive sheet of phosphorescence was seen extending from east to west as far as the eye could reach. The luminosity was confined to the range of animals in this shoal, for there was no similar light in any other direction. I immediately cast the towing-net over the stern of the ship as we approached the luminous streak. The vessel soon cleaved through the brilliant mass, which (judging from the rate of sailing) may have been a mile in breadth, and which emitted stronger flashes on being disturbed, illuminating all around. On taking in the net it was found half filled with *Pyrosoma* (Greek, *pyr*, fire; *soma*, body—literally, " fire-body") which shone with a beautiful pale-greenish light, and flashed into brighter tints when handled or excited. The *Pyrosoma Atlanticum* which produces this peculiar light is one of the tunicated molluscs (that is, enclosed in a tough membranous coat instead of a shell), and is composed of an aggregation of small tunicaries, cylindrical in form, open at both extremities, and enclosed in a common membrane. It is usually

from three to four inches in length and about an inch and a half in circumference. Its colour is yellowish-white, but sometimes it is perfectly colourless; its surface is studded with prominent pearly tubercles; scattered about are a great number of dots of a brownish or reddish-brown colour, and in these the phosphorescent power is supposed to reside. When at rest, no light is emitted; but on moving (which it does by dilating and contracting), or on being disturbed even in a very slight degree, the whole aggregate mass becomes vividly illuminated.

On the 18th of July, in lat. 39° S. and long. 127° W., with the thermometer at 52°, a brilliant phosphorescence of the ocean was visible. It appeared in glowing masses of light, distinguishable at brief intervals, and so distinct that they were named "floating lanterns;" and those observed at a greater distance from the ship were compared to "fishermen's lights in the Channel." These were produced by a very large species of *Medusa*, or jelly-fish, seen floating about during the day and becoming luminous at night. The brilliancy was increased by the very dark, squally, and tempestuous weather which prevailed at the time. At 8 P.M. the phosphorescence became very brilliant; and from that time till 10 P.M. the "lanterns" were blazing with great splendour; after which they became dim and were suddenly extinguished. In lat. 21° N. and long. 21° W. a number of luminous *Salpae* (a genus of which float about in the open sea, and are composed of tunicated molluscs with a transparent, elastic, external membrane) were taken, united together in a long chain like clustered crystals; and on the slightest agitation numerous vivid spots rapidly stirred themselves and flitted over the surface of the body. On examining the water from Sydney Harbour, which, being agitated, diffused a phosphoric light, nothing could be detected by the naked eye; but on placing it under the microscope a number of minute points, apparently of a jelly-like substance, could be seen, similar to those on the coast of England, and to which the name of *Noctiluca* (night-lights) has been applied. Upwards of 30,000 of these are estimated to be contained in a cubic foot of highly luminous sea-water; and hence

the light emitted by a passing keel or the sudden stroke of an oar. A fish which excited my very great surprise when I first captured it in the towing-net was the luminous shark (*Squalus fulgens*). This was taken in the tropics, and on placing it in sea-water and observing it in the dark cabin, it swam about for some time, emitting a brilliant phosphoric light; and when this became faint, it was readily rekindled on the animal being disturbed. My specimen was about one and a half feet long, of a perfectly black colour, and died about four hours after it had been taken. The luminosity was retained for some hours after life was extinct, and appears to reside in a peculiar secretion from the skin. The luminous secretion exists also among many of the coral zoophytes; for among the Polynesian Islands, when the boat has touched the coral-reefs in passing between them, I have frequently observed a vivid stream of phosphoric light suddenly produced by the friction.

It has been asserted that calm weather, heat, and a superabundance of electricity in the atmosphere increase the intensity of the phosphorescence; but these assertions are not verified by facts; for in the tropics, even with a combination of these favourable circumstances, there is often no luminosity visible; while, on the other hand, in high latitudes, and during the low temperature of winter, a very vivid illumination has been known to overspread the ocean.—*Abridged and adapted from* BENNET'S *Gatherings of a Naturalist in Australasia.*

TECHNICAL.

MAN AND THE INDUSTRIAL ARTS.

THE Industrial Arts are necessary arts. The most degraded savage must practise them, and the most civilized genius cannot dispense with them. Whatever be our gifts of intellect or fortune, we cannot avoid being hungry, and thirsty, and cold, and weary every day; and we must fight for our lives against the hunger, and thirst, and cold, and weariness, which wage an unceasing war against us. But though the Industrial Arts are common, they are not ignoble arts. They minister, indeed, to those physical wants which we share with the lower animals, but we are raised above them as much by being industrial as by being æsthetic artists. We are the former in virtue of our superior intellect, as we are the latter in virtue of our superior imagination.

Let me ask your attention to this point. It is with every-day life, and every-day cares, that the Industrial Arts have to do; with man, not as "a little lower than the angels," but "as crushed before the moth," and weaker than the weakest of the beasts that perish; with man as a hungry, thirsty, restless, quarrelsome, naked animal. But it is my province to show that man, because he is this, and just because he is this, is raised, by the industrial conquests which he is compelled to achieve, to a place of power and dignity, separating him by an absolutely immeasurable interval from every other animal.

It might appear, at first sight, as if it were not so. As industrial creatures we often look like wretched copyists of animals far beneath us in the scale of organization; and we seem to con-

fess as much by the names which we give them. The mason-wasp, the carpenter-bee, the mining caterpillars, the quarrying sea-slugs, execute their work in a way which we cannot rival or excel. The bird is an exquisite architect; the beaver a most skilful bridge-builder; the silk-worm the most beautiful of weavers; the spider the best of net-makers. Each is a perfect craftsman, and each has his tools always at hand. Those wise creatures, I believe, have minds like our own, to the extent that they have minds, and are not mere living machines, swayed by a blind instinct. They will to do one thing rather than another, and do that one thing in different ways at different times. A bird, for example, selects a place to build its nest upon, and accommodates its form to the particular locality it has chosen; and a bee alters the otherwise invariable shape of its cell, when the space it is working in forbids it to carry out its hexagonal plan. Yet it is impossible to watch these, or others among the lower animals, and fail to see that, to a great extent, they are mere living machines, saved from the care and anxiety which lie so heavily upon us, by their entire contentment with the present, their oblivion of the past, and their indifference to the future. They do invent, they do design, they do exercise volition in wonderful ways; but their most wonderful works imply neither invention, contrivance, nor volition, but only a placid, pleasant, easily rendered obedience to instincts which reign without rivals, and justify their despotic rule by the infallible happiness which they secure. There is nothing, accordingly, obsolete, nothing tentative, nothing progressive, in the labours of the most wonderful mechanicians among the lower animals.

To those wise creatures the Author of All has given, not only infallible rules for their work, but unfaltering faith in them. Labour is for them not a doubt, but a certainty. Duty is the same thing as happiness. They never grow weary of life; and death never surprises them. Wonderful combinations of individual volition, pursuing its own ends, and of implicit surrender to Omnipotent will, subduing all opposition, they are most wonderful in the latter respect, and are less to be likened to us

than to perfect self-repairing machines, which swiftly raise our admiration from themselves to Him who made and who sustains them.

We, on the other hand, are industrial for other reasons, and in a different way. Our working instincts are very few; our faith in them still more feeble; and our physical wants far greater than those of any other creature. With the intellects of angels, and the bodies of earth-worms, we have the power to conquer, and the need to do it. Half of the Industrial Arts are the result of our being born without clothes; the other half, of our being born without tools. I use this language deliberately.

I do not propose to offer you a catalogue of the arts which our unclothedness compels us to foster. The shivering savage in the colder countries robs the seal and the bear, the buffalo and the deer, of the one mantle which Nature has given them. The wild huntsman, by a swift but simple transmutation, becomes the clothier, the tailor, the tanner, the currier, the leather-dresser, the glover, the saddler, the shoemaker, the tent-maker. And the tent-maker, the arch-architect of one of the great schools of architecture, becomes quickly a house-builder, building with snow where better material is not to be had; and a ship-builder, constructing, out of a few wooden ribs and stretched animal skins, canoes which, as sad experience has too recently shown us, may survive where English ships of oak have gone to destruction, we know not where.

Again: the unchilled savage of the warmer regions seeks a covering, not from the cold, but from the sun, which smites him by day, and the moon, which smites him by night. The palm, the banana, the soft-barked trees, the broad-leaved sedges and long-fibred grasses are spoiled by him, as the beasts of the field are by his colder brother. He becomes a sower, a reaper, a spinner, a weaver, a baker, a brewer, a distiller, a dyer, a carpenter; and whilst he is these, he bends the pliant stems of his tropical forests into roof-trees and rafters, and clothes them with leaves, and makes for himself a tabernacle of boughs, and so is the arch-architect of a second great school of architecture; and, by-and-by,

his twisted branches and interlaced leaves grow into Grecian columns with Corinthian acanthus capitals, and Gothic pillars with petrified plants and stony flowers gracefully curling round them.

Once more: in those temperate regions where large animals and trees do not greatly abound, turfs, or mud, or clay, or stones, or all together, can be fashioned into that outermost garment which we call a house, and most familiarly connect with the notion of architecture.

It is not, however, his cultivation of the arts which have been named, or of others, that makes man peculiar as an industrial animal—it is the mode in which he practises them. The first step he takes towards remedying his nakedness and helplessness is in a direction where no other creature has led the way, and none has followed his example. He lays hold of that most powerful of all weapons of peace or war, *Fire*, from which every other animal, unless when fortified by his presence, flees in terror; and with it alone not only clothes himself, but lays the foundation of a hundred arts.

Man may be defined as the only animal that can strike a light—the solitary creature that knows how to kindle a fire. This is a very fragmentary definition of the "paragon of animals," but it is enough to make him the conqueror of them all. The most degraded savage has discovered how to rub two sticks together, or whirl the point of one in a socket in the other till the wood is kindled. It is a thoroughly technical process, not easily learned or practised. Judgment, dexterity, and patience are needed for its performance; and even the most sagacious of monkeys, though he has a pair of hands more than a man, has never attempted this primitive pyrotechnic art.

Once provided with his kindled brand, the savage technologist soon proves what a sceptre of power he holds in his hand. He tills with it; by a single touch burning up the withered grass of a past season, and scattering its ashes to fertilize the plains, which will quickly be green again. It serves him as an axe to fell the tallest trees with, and hollows out for him the canoe in which he adventures upon strange seas. It is an all-sufficient defence

against the fiercest wild beasts; and it reduces for him the iron ore of the rocks, and forges it into a weapon of war. I might say, indeed, with truth, that his kindled brand makes the ten-fingered savage, without further help, a farmer, a baker, a cook, a carpenter, a smith, a potter, a brick-maker, a lime-burner and a builder; and, besides much else, a soldier and a sailor.

You may think this sketch of the savage's obligation to fire fanciful and exaggerated; but if you consider how every human industrial art stands directly or indirectly related to fire, whilst no animal art does, you will not regard the statement as extravagant. And civilized man, as much as his savage brother, is a fire-worshipper in his practical doings. The great conquering peoples of the world have been those who knew best how to deal with fire. The most wealthy of the active nations are those which dwell in countries richly provided with fuel. No inventions have changed the entire world more than steam and gunpowder. We are what we are, largely because we are the ministers and masters of Fire.

Clotheless creatures by birth, we are also tool-less ones. Every other animal is by nature fully equipped and caparisoned for its work; its tools are ready for use, and it is ready to use them. We have first to invent our tools, and then to fashion them, and then to learn how to handle them. Man's marvellous hand is, no doubt, in itself an exquisite instrument of art; but, after all, our hands are less adroit than those of the monkey, who has four, each equivalent to a right hand, whilst the handiest of us is only ambidextrous. Our right hands would be nothing to us but for our wise heads; for we have to begin two steps further back, in our industrial labours, than the meanest of the animals, who practise no such craft as that of tool-making, and serve no apprenticeship to any craft. Two-thirds, at least, of our industrial doings are thus preliminary. Before two rags can be sewed together we require a needle, which embodies the inventiveness of a hundred ingenious brains; and a hand, which only a hundred botchings and failures have, in the lapse of years, taught to use the instrument with skill.

It is so with all the crafts, and they are inseparably dependent on each other. The mason waits on the carpenter for his mallet, and the carpenter on the smith for his saw; the smith on the smelter for his iron, and the smelter on the miner for his ore. Each, moreover, needs the help of all the others;—the carpenter the smith, as much as the smith the carpenter; and both the mason, as much as the mason both. This helplessness of the single craftsman is altogether peculiar to the human artist. The lower animals are all polyartists, and never heard of such a doctrine as that of the division of labour. The same bee, for example, markets, and bakes bee-bread, and manufactures sugar, and makes wax, and builds storehouses, and plans apartments, and nurses the royal infants, and waits upon the queen, and apprehends thieves, and smites to the death the enemies of the Amazons. Nor are there degrees of skill among the animal artists. The beavers pay no consulting fees to eminent beaver engineers experienced in hydraulics; the coral insects do not offer higher wages to skilled workmen at reef-building; every nautilus is an equally good sailor; and the wasps engaged in "just and necessary wars," offer no bounties to tempt veteran soldiers into their armies.

The industrialness, then, of man is carried out in a way quite peculiar to himself, and singularly illustrative of his combined weakness and greatness. The most helpless, physically, of animals, and yet the one with the greatest number of pressing appetites and desires, he has no working instincts to secure (at least after infancy) the gratification of his most pressing wants, and no tools which such instincts can work by. He is compelled, therefore, to fall back upon the powers of his reason and understanding, and make his intellect serve him instead of a crowd of instinctive impulses, and his intellect-guided hand instead of an apparatus of tools. Before that hand, armed with the tools which it has fashioned, and that intellect, which marks man as made in the image of God, the instincts and weapons of the entire animal creation are as nothing. He reigns, by right of conquest, as indisputably as by right of inheritance, the king of this world.—*Abridged:* Dr. George Wilson.

SILK-WORM CULTURE IN CHINA.

In sailing up the Lun-ke river I observed that the plantations of mulberry still formed the staple crop of the country on all the flat lands which were raised above the surface of the rice-fields. About sixty *le* west of Hoo-chow-foo I observed a large monastery, not far from the banks of the river, and, as it seemed, situated in the midst of rich and luxuriant vegetation. I determined to moor my boat, and remain in the neighbourhood for a few days. If there was little to notice in the halls and temples of this monastery with reference to Buddhism and its rites, there were objects of another kind that soon attracted my attention. The halls and out-houses seemed to be converted for the time into a place for feeding silk-worms. Millions of those little animals were feeding in round sieves, placed one above another in open frame-work made for the purpose. So great was the number of the worms, that every sieve — and there must have been hundreds of them—was crammed quite full. In one large hall I observed the floor completely covered with worms. I shall never forget the peculiar sound which fell upon my ear as I opened the door of this hall. It was early in the morning, the worms had just been fed, and were at the time eagerly devouring the leaves of the mulberry. Hundreds of thousands of little mouths were munching the leaves, and in the stillness around this sound was very striking and peculiar. The place, too, seemed so strange—a temple—a place of worship—with many huge idols, some from twenty to thirty feet in height, looking down upon the scene on the floor. But to a Chinese there is nothing improper in converting a temple into a granary or a silk-worm establishment for a short time, if it is required; and I suppose the gods of the place are thought to look down with approbation on such scenes of peaceful industry.

When, from the large number of worms, it is necessary to feed them on floors of rooms and halls, there is always a layer of dry straw laid down to keep them off the damp ground. This mode

of treatment is resorted to from necessity, not from choice. The sieves of the establishment, used in the frame-work I have already noticed, are greatly preferred. But whether the worms are fed on sieves or on the floor, they are invariably cleaned every morning. All the remains of the leaf-stalk of the mulberry, the excrement of the animals, and other impurities, are removed before the fresh leaves are given. Much importance is attached to this matter, as it has a tendency to keep the worms in a vigorous and healthy condition. The Chinese are also very particular as regards the amount of light which they admit during the period the animals are feeding. I observed the rooms were always partially darkened, no bright light being allowed to penetrate. In many instances the owners were most unwilling to open the doors, for fear, as they said, of disturbing the worms; and they invariably cautioned me against making any unnecessary noise while I was examining them.

At this time (early in June) all the labour in this part of the country was expended upon the production of the silk-worm. In the fields the natives were seen in great numbers busily engaged in gathering the mulberry leaves; boats on the river were fraught with them; in the country markets they were exposed for sale in great quantities—and everything told they were the staple article of production. On the other hand, every cottage, farm-house, barn, and temple, was filled with its thousands of worms, which were fed and tended with the greatest care. This part of the country is very populous; villages and small towns are scattered over it in every direction; and the people have the same clean and respectable appearance which I have already remarked in other parts of the silk-rearing districts. In making my observations on the culture of the silk-worm, I visited many hundreds of these towns and villages, and never in one instance had any complaint to make of incivility or obstruction.

On my way up from Hoo-chow-foo to Mei-che, where the river is no longer navigable for low-country boats, and about the 23rd of June, I observed that many of the worms had ceased to feed,

and were beginning to spin. The first indication of this change is made apparent to the natives by the bodies of these little animals becoming more clear, and almost transparent. When the change takes place, they are picked one by one out of the sieves and placed upon bundles of straw to form their cocoons. These bundles of straw, which are each about two feet in length, are bound firmly in the middle; the two ends are cut straight, and then spread out like a broom; and into these ends the worms are laid, when they immediately fix themselves and begin to spin. During this process I observed that the under-side of the framework on which the bundles of straw were placed was surrounded with cotton cloth, to prevent the cold draught from getting to the worms. In some instances small charcoal fires were lighted and placed under the frame, inside the cloth, in order to afford further warmth. In some of the cottages the straw covered with spinning worms was laid in the sun, under the veranda in front of the doors.

In a few days after the worms are put upon the straw, they have disappeared in the cocoons, and have ceased to spin. The reeling process now commences, and machines for this purpose were seen in almost every cottage. This apparatus may be said to consist of four distinct parts, or rather, I may divide it into these for the purpose of describing it. There is, first, the pan of hot water into which the cocoons are thrown; second, the little loops or eyes through which the threads pass; third, a lateral or horizontal movement, in order to throw the silk in a zigzag manner over the wheel; and lastly, the wheel itself, which is square. Two men, or a man and a woman, are generally employed at each wheel. The business of one is to attend to the fire, and to add fresh cocoons as the others are wound off. The most expert workman drives the machine with his foot, and attends to the threads as they pass through the loops over on to the wheel. Eight, ten, and sometimes twelve cocoons are taken up to form one thread; and as one becomes exhausted, another is taken up to supply its place. Three, and sometimes four of such threads, are passing over on the wheel at the same time. The lateral or zig-

zag movement of the machine throws the threads in that way on the wheel; and this, I believe, is considered a great improvement upon the Canton method, in which the threads are thrown in a parallel manner.

The water in the pan into which the cocoons are first thrown is never allowed to boil, but it is generally very near the boiling point. A slow fire of charcoal is also placed under the wheel. As the silk is being wound, this fire is intended to dry off the superfluous moisture which the cocoons have imbibed in the water in which they were immersed. As silk is a very valuable production, it is reeled with more than ordinary care; and I observed that in almost all instances a clean, active, and apparently clever workman, was intrusted with the reeling process. The quantity of silk produced here was very large; and all hands, from the peasant to the priest, were employed in reeling and sorting it for the market.

About the middle of July the winding of the cocoons had ceased almost everywhere; and a few days after this there was scarcely a sign of all that life and bustle which is visible on every side during the time the silk is in hand. The clash of the winding-machines, which used to be heard in every cottage, farmhouse, and temple, had now ceased; the furnaces, pans, and wheels, with all the other apparatus in common use during the winding season, had been cleared away; and a stranger visiting that country now could scarcely believe that such a busy, bustling scene had been presented only a few days before.—*Abridged from* FORTUNE'S *Residence among the Chinese.*

COINING AT THE ROYAL MINT.

THE operations of coining, as pursued at the Royal Mint, are among the most beautiful presented by any branch of manufacture, owing to the extreme accuracy required in the quality, size, shape, weight, and device of the coins. The difference between the gold, silver, and copper coins lies rather in the value

of the metal than in the process of coining. The various steps by which a sovereign is produced may therefore conveniently be taken to represent the whole art of coining.

Gold is sent from the Bank of England to the Mint in the form of ingots, each weighing about 180 ounces. These ingots have been previously tested by the bank assayer, and they now undergo a similar process by the Mint assayer, in order to ascertain exactly in what measure each particular ingot differs from the standard of absolute purity. As pure gold would be too soft for coins, a little silver or copper (usually the latter) is added to harden it; the regular proportion for standard or sterling gold being that every twenty-four parts of standard shall contain twenty-two of pure gold and two of alloy.

The total quantity of gold and alloy in these proportions is first divided into lots of 1200 ounces, for the purpose of being melted down into bars of standard gold. The melting-pots in which this is effected are made of a mixture of Stourbridge clay and plumbago, or black-lead, and are nine inches deep by seven inches across the mouth. Each pot or crucible is made white-hot in a highly-heated furnace; the ingots and the alloy are introduced, and the melting takes place. The moulds into which the molten metal is poured are made of upright iron bars, temporarily held together by clamps and screws. About sixteen of these moulds are placed side by side in a frame, and four pots of molten gold fill them all. When the gold has slightly cooled, the moulds are taken to pieces and the bars of gold liberated.

We have now bars of standard gold. The workman seizes each bar with a kind of tongs, and plunges it into cold water, to expedite the cooling; after which the bars are stamped with certain letters and figures, and two assay-pieces are cut from each. The bars are 24 inches long, 1·375 inches broad, and one inch thick, for making sovereigns; those for other coins, whether gold, silver, or copper, differ in dimensions. The two assay-pieces from each bar are sent to two assayers, one to each, and are by them subjected to a most scrupulous process of assaying or analysis, to determine whether the proper share of alloy, neither

more nor less, has been mixed with the gold. The assayers give in their report to the Master of the Mint, and if he is satisfied, the master-melter is considered to have done his duty, and the bars are passed into the hands of the weighers. The balance used at the Mint for weighing standard gold bars is so delicate, and at the same time so strong, that it will turn with one single grain when loaded with a thousand ounces! Each bar, when weighed, is passed through a breaking-down mill, by which two steel rollers so compress it as to lessen the thickness—at the same time increasing the length, but not the width. Seven times over is this done, the rollers being brought closer together each time. The gold being made hard by this rolling, each elongated bar is cut into portions of 18 inches long; and these portions, when annealed by heating and cooling, are called fillets. The fillets are rolled again and again, until they are 0·117 of an inch thick; then transferred to another mill, and then to another, until at length they are brought very accurately to 1·829 inches wide by 0·53 thick—that is, rather less than two inches wide and one-nineteenth of an inch thick. Not only this, but there are even still more delicate machines used, to assure that every fillet shall be exactly of the same thickness in every part, even to the thousandth of an inch; and then there is a process of drawing, something like wire-drawing.

At length, after a long series of rollings and testings, weighings and gaugings, the fillets are cut up into blanks or circular pieces, each for one sovereign. This is effected by means of cutting-out presses, of which there are twelve at the Mint. A workman pushes the fillet underneath a cutting punch, which descends and cuts out a circular piece; and this is repeated until as many blanks are obtained as the length and width of the fillet will yield—the remainder, called *scissel*, being laid aside for re-melting. Some of these blanks, taken indiscriminately, are tested as to weight and size, to see that the cutting-out punches are working properly. About 720 ounces of blanks are put into a bag and taken into the weighing-room, where are at work several machines of marvellous beauty in construction and accu-

racy. They not only weigh the blanks singly, but separate them in a way which one would suppose human intelligence could alone effect—throwing into one receptacle those which are of the proper weight, into another those which are too heavy, and into a third those which are too light. A workman places a pile of gold blanks into a kind of trough, and then leaves the machine to do all the rest. We see the blanks fall one by one into little slits at the bottom of the machine, and to determine which of the three slits shall receive any particular blank, the machine weighs it. By law a sovereign is allowed to vary a little from an average weight of 123¼ grains; this is allowed because absolute accuracy is really unattainable, but the error must never be greater than about one-quarter of a grain, either in excess or deficit. Visitors never fail to admire the action of these exquisite machines, which thus weigh and separate twenty-three blanks in a minute. The light blanks are consigned again to the melting-pot, while the heavy blanks are passed through a peculiar filing-machine, which files away the edges until the proper size and weight are produced. A very odd process then ensues. A boy grasps two heaps of blanks in his two hands, and dashes each blank down on a block separately; by the ring or sound he can tell whether it is cracked (a result of any air bubbles which insinuate themselves during the melting), and each of these defaulters is laid aside for re-melting. The rapidity with which the boy applies this test to every blank is something amazing. The blanks then pass, at the rate of seven hundred per minute, through an edge-compressing machine, where they are slightly lessened in diameter and slightly thickened at the edge. Then they are annealed in an oven, cooled in water, boiled in diluted sulphuric acid, cooled again in water, dried partly with sawdust, and fully dried in an oven.

At length the actual coining or stamping takes place. There are two steel dies, one for each side of a sovereign; and by means of an alternate hardening and softening, with great pressure, these dies can be multiplied from one original, so that when one is worn out another may be ready to replace it. One

single blow suffices to stamp every part of a blank, the two surfaces and the edge. There is a die above, a counter-die below, and a collar to give a milled or serrated edge to the coin. This milling of the edge is adopted to afford an immediate *exposé* of any attempt to deteriorate the coin by clipping. The presses by which this stamping is effected are wonderfully complete pieces of machinery; but they produce a deafening noise while at work, and sorely bewilder a bystander unaccustomed to the place.

The sovereigns are now made, each of them almost exactly 0·868 inches in diameter. The sovereigns fall from the presses into a tray, and are examined one by one, to pick out imperfect specimens or "blockages." Bags containing seven hundred each are taken to another room, where a small number of sovereigns, indiscriminately chosen, are weighed and assayed, as a last test of the accuracy of the whole manufacture. Forty pounds troy weight of standard gold make exactly 1869 sovereigns, so that the legal weight of each can be determined to a minute fraction of a grain.

The law allows a certain margin of error, called the *remedy*, on account of the impossibility of insuring absolute accuracy. But the remedy is, as we have said, exceedingly minute; and the authorities of the Mint have therefore every reason to observe the most searching exactness in all their proceedings. Now and then the Government holds a curious ceremony, called the *Trial of the Pyx*, at which specimens of all the gold and silver coinages struck since the last preceding trial are scrupulously weighed and tested. If they are beyond the limits of the remedy or allowance, the Mint authorities lose the difference. In nearly every Trial of the Pyx the errors have been found to be within the allowance, so wonderful is the care with which all the operations are conducted. The quality of the gold more frequently errs by being a little more or a little less pure than the absolute standard; but as far as regards this minute difference the public are gainers rather than losers.

Crowns and half-crowns are not now coined; we are swiftly using up those which were coined many years ago. The same is

the case with fourpenny-pieces. Copper coinage is now superseded by bronze, which consists of ninety-five parts of copper, four of tin, and one of zinc. The small admixture of the two last-named metals gives hardness and durability to the copper; while the bronze money is so much less weighty than the copper, value for value, that it is more easily carried in the pocket.—*People's Magazine.*

MANUFACTURE OF LACE.

Lace is made of various substances;—of flax, cotton, and mohair; of silk, gold, and silver. It is fabricated in various manners—by the needle, on the pillow, and by machinery.

To Italy is assigned the invention of point or needle-made lace, but its fabrication has always been the favourite occupation of the convent in all countries, and throughout many centuries to the present day, for the adornment of the altar and its ministers.

The earliest productions of the needle consisted of darned netting and cut work. In the first, a net-work arranged in squares upon a frame was darned or embroidered with patterns or figures. This work has lately been revived under the old name of "Filet."

Cut work was formed by drawing the threads of linen, and working them with button-hole stitch into various geometric figures, the superfluous cloth being cut away. For these works various pattern-books were published in the fifteenth and sixteenth centuries, among which that of the Venetian Vinciolo was most widely circulated.

The Netherlands lays claim to the invention of the pillow; and during the fifteenth and sixteenth centuries she supplied lace-makers to all Northern Europe. From Flanders Barbara Uttmann procured assistants to set up her workshop at Annaberg, and extended the art of lace-making over the Hartz Mountains; Brabant workmen established the lace manufacture of Denmark at Tonder; and refugees from the Alva persecutions carried their industry to Honiton. When Colbert gave the first impulse to

the lace manufactures in France, so great was the rush of lace-makers to that country that the Government of the Netherlands issued an edict prohibiting their emigration under severe penalties.

France, more especially, is a lace-wearing as well as a lace-making country. Of the Valenciennes lace, made in Belgium, France alone buys more than all other countries united. The taste for wearing lace, introduced by the Italian queens of France, attained under Louis XIII. to the most extravagant pitch. Nor were the courtiers of the Regency, in the ensuing reign, less lavish in their use of this costly fabric, and fortunes were expended in its purchase. In vain were sumptuary edicts issued by successive ministers prohibiting the entry of the laces of Italy and Flanders. Prohibition only increased the demand, and every attempt to stop the growing evil was powerless, until Colbert came into power, and devised a surer remedy. He resolved to develop the lace industry in France, and to produce fabrics which should rival in beauty the coveted "points" of Italy and Flanders; so that if fabulous sums were expended on such luxuries, the money to procure them should not go out of the country.

Sending to Venice for practised workmen, he established them at his chateau of Lonray, near Alençon, under the direction of Madame Gilbert, herself an experienced lace-maker. The king, Louis XIV., was invited to inspect the first productions of his fabric. He expressed himself delighted, gave large orders himself, and desired no other lace should be worn at court except the new manufacture, upon which he bestowed the name of "Point de France." Encouraged by his success, Colbert established fabrics of point and pillow lace in other towns of the kingdom; lace manufactories started up in every direction; and to Colbert France owes the development of an industry which now employs 200,000 of her female population.

The manufacture of Alençon, supported by fashion and court favour, continued to flourish, and never were its products in greater demand than in the reign of Louis XV. It fell with the

Monarchy, but was revived with the first Napoleon, who gave large orders to Alençon on his marriage with Marie Louise. The fabric again fell with the First Empire, to revive in unequalled splendour under the Second. Specimens of matchless beauty appeared in the *corbeille de mariage* of Her Majesty the Empress, and the *layette* of the Prince Imperial was no less costly. The curtains and bed trimmings of the cradle presented by the city of Paris to the imperial infant were of the most finished workmanship, and cost 120,000 francs (£4800).

Next in importance to Alençon is the black lace of Normandy. The fabric extends throughout the department of Calvados, but it is at Bayeux it has attained its greatest perfection. The Normandy lace-makers owe their prosperity to the invention of the "point de raccroc," or fine joining, by means of which they are enabled to make shawls, flounces, and other large pieces, in a number of separate segments, and then join them invisibly together.

The department of the Haute-Loire, part of the old province of Auvergne, is, after Normandy, one of the principal lace districts of France. The whole of the women are lace-makers from their cradles. As soon as the infant can use her hands, instead of a doll, a small lace pillow, with three threads fixed upon a nail, is given to her as a toy, and her tiny fingers are taught to plait the threads. As she grows older, a more complicated frame is substituted, and she begins to fabricate a narrow lace; a child of six years old has been known to earn a halfpenny (two *liards*) a day. Lace-making at Le Puy is not only a trade, but a passion. It is the infant's plaything, the woman's support; and, when old and obliged to return to the simple laces of childhood, the aged work-woman will ply at her pillow so long as her eyes can distinguish or her fingers move the bobbins.

From France we pass to Belgium—the classic land of lace. Its manufacture has always proved a principal source of national wealth; and when other industries have disappeared in times of persecution and war, the lace fabric has, by its prosperity, upheld the failing resources of the country. It is now even more flourish-

ing than in the most palmy days of the Netherlands. Lace-making forms a branch of the national education, and employs, it is said, one-fortieth of the population of Belgium.

Brussels lace is unrivalled in delicacy and beauty. Like Alençon, it is made in small pieces and afterwards joined together. The thread employed is of the finest texture. In the "application" lace, the flowers are sewn on the ground; both point à l'aiguille and point-plat are so applied. Brussels lace is much reduced in price since the invention of "Brussels net," a very fine machine-made fabric, which has entirely replaced the pillow-made grounds; but the point à l'aiguille ground is still used for the finer pieces of Brussels lace.

Brussels lace was at one time known under the name of "Point d'Angleterre," a denomination it has entirely lost. It arose from this circumstance: The English Parliament, alarmed after the Restoration at the vast sums expended upon foreign lace, and also with the view to protect the native industry, passed an Act prohibiting the importation of foreign lace. At a loss how to supply their customers, the English lace-merchants endeavoured to produce a similar fabric at home; but their attempt proving unsuccessful, they bought up the finest laces of Brussels, and causing them to be smuggled into England, sold them under the name of "Point d'Angleterre."

Next in importance to Brussels is the manufacture of Valenciennes lace, which, after attaining its climax in its native city, fell, at the Revolution, never to flourish there again. From France it has passed to Belgium, where its manufacture occupies the lace-makers of East and West Flanders. Valenciennes is made entirely on the pillow, pattern and ground together, and with the same thread. Its workmanship is most elaborate; more bobbins are required to form the ground than in any other lace. From its solidity it was called "eternelles Valenciennes." The transfer of its manufacture to Belgium was a great commercial loss to France, as more is consumed of Valenciennes than of any other lace.

Mechlin is now but little in favour. It was the favourite

pillow lace of the last century. Both pattern and ground are made together. The flat thread which forms the flower gives it the character of embroidery. Some is still fabricated at Malines and Antwerp.

In England, Honiton lace takes the first place. The industry was introduced by Brussels settlers, who left their country to escape the tyranny of the Duke of Alva. The Honiton sprigs have always been highly esteemed. At first they were made separately and worked in with the ground, like the old Brussels lace. Later, they were "applied." The ground was of extraordinary firmness, made with thread which cost £70 per pound at Antwerp, and the worker was paid proportionately for her labour; but, as in Brussels, the invention of machine-made net caused the pillow grounds to be disused, and the flowers were applied upon the cheaper material. The bobbin-net ground has again succumbed to fashion, and the flowers are united by "pearl ties," and various other fancy stitches.

Since the application of the Jacquard system to the bobbin-net machine, every description of lace has been made by machinery at Nottingham and St. Pierre les Calais. But while the machine places lace, by its cheapness, within the reach of all, it has never lessened the demand for the productions of the needle and the pillow, which still realize the high prices due to their delicate texture and exquisite workmanship.—*Abridged:* MRS. BURY PALLISER *in Art Journal.*

MAHOGANY FELLING IN HONDURAS.

THE mahogany tree of Honduras (*Swietenia mahogoni*), in respect of its vast size and magnificent foliage, is entitled to be called "King of the Forest." In comparison with it all other trees dwindle into insignificance. The enormous bulk and height of the trunk, the vast spread of its branches, and the space of ground occupied by its roots, are equally remarkable. It is of exceedingly slow growth, hardly manifesting a perceptible increase in

the narrow span of a man's life. It has been calculated that it requires three hundred years wherein to attain a growth proper for cutting. Some idea may be formed of the great size which it sometimes attains from the fact that the lower section of a tree seventeen feet long has been known to measure "in the square" five feet six inches—equal to 550 cubic feet, and a weight of seventeen tons!

The mahogany grows in nearly all parts of Honduras, in the valleys of the various streams. It is, however, most abundant upon the low grounds which border the rivers flowing into the Bay of Honduras, where it also attains its greatest size and beauty, and where the mahogany works are chiefly situated. As these lands are for the most part the property of the State, the wood is cut under license from the Government, which exacts a fixed sum for each tree. Except those made at the mouths of the various rivers, for receiving, marking, and shipping the wood as it is floated down, the mahogany establishments are necessarily temporary, and are changed from time to time as trees become scarce in their neighbourhood.

Of all occupations known to man, that of the mahogany-cutter is perhaps the wildest in its nature, and yet among the most systematic in its arrangements. When the cutter has fixed upon the valley of some river as the field of his operations, he makes a depôt for storing provisions and for securing and embarking the wood. Here he maintains a fleet of *pit-pans* (a kind of flat-bottomed canoe), for carrying supplies and keeping up relations with the "works" proper, the sites of which are determined chiefly by the abundance of trees, their accessibility, and the means that exist for feeding the cattle which it is necessary to use in "trucking" the wood. To these points it is often necessary to drive the oxen through thick and untracked forests; and to carry the chains and trucks, by means of small boats, against strong currents, or over shallows and rapids, which are only surmounted with infinite labour.

The site once definitively fixed upon, the next step is to erect temporary dwellings for the men—a task of no great difficulty,

as the only requisite is protection from the sun and rain, which is effected by a roof thatched with long grass from the swamps, or with the leaves of the thatch-palm. A hammock swung between two posts, two stones to support his kettle, and the hut of the cutter is both finished and furnished!

The mahogany season, which lasts some months, commences in August of each year; it being the opinion of cutters that the wood is not then so apt to split in falling, nor so likely to "check" in seasoning as when cut from April to August, or what is called "the spring." Furthermore, by commencing at this period, the cutter is enabled to get down his wood and prepare it for trucking by the setting in of the dry season.

The labourers are divided into gangs of from twenty to fifty each, under the direction of a leader styled a "captain," who meets his company and assigns them their daily tasks. Each gang has one person connected with it who is called a "hunter," whose duty is to search for trees proper to be felled. His work, therefore, commences somewhat earlier than that of the others; and as it involves activity and intelligence, he is paid much higher wages than the mere cutters. His first movement is to cut his way through the thickest of the forest to some elevated situation, where he climbs the tallest tree he can find, and thence minutely surveys the surrounding country.

At this season of the year (August) the leaves of the mahogany tree are invariably of a yellow-reddish hue, and an eye accustomed to this kind of work can, at a great distance, discover the spot where the wood is most abundant. The treasure being thus discovered, the next operation is the felling of a sufficient number of trees to employ the gang during the season. The tree is commonly cut about ten feet from the ground, a stage being erected for the axe-man employed in levelling it. The trunk of the tree, from the dimensions of the wood it furnishes, is deemed most valuable; but for purposes of an ornamental kind, the limbs or branches are generally preferred, their grain being much closer, and the veins or "figure" richer and more variegated.

A sufficient number of trees being cut, the preparations for

"trucking" commence by the opening of roads from the places where they lie to the nearest river. The clearing of such roads through the dense forest and undergrowth, and the construction of temporary bridges over runnels and streams, are works often of great difficulty and labour. The roads being finished generally about the month of December, the trees are sawn into logs of various lengths, and placed in whatever position will admit of the largest square being formed, according to the shape which the ends present. They are reduced from the round or natural form into "the square" by means of the axe; and although some of the smaller logs are brought out in "the round," yet with the larger description the making them square is essential, not only to lessen their weight, but also to prevent their rolling on the truck or carriage.

In the months of April and May, all the various preparations having been completed, and the dry season having become sufficiently advanced to render the ground firm, the "trucking" and "drawing" commence in earnest. From the intense heat of the sun, men and cattle are unable to work during the day, and consequently this process has to be performed during the night. Nothing can present a more extraordinary appearance than the trucking and drawing of the mahogany through the midnight forests down to the river. The great number of oxen; the drivers half naked, and each bearing a torch-light; the wildness of the forest scenery; the rattling of chains; the crack of the whip; shouts of encouragement, and snatches of song,—the whole stream of activity and exertion echoing through the woods ill corresponds with the dead hour of midnight, and looks more like some dramatic exhibition than what it really is, namely, the pursuit of industry which has fallen to the lot of the Honduras wood-cutter.

About the end of May the periodical rains again commence, and in the course of a single day the roads are rendered impassable, and all trucking ceases. The cattle are turned into the pasture, and the trucks, gear, and tools are housed for the season. The rain now pours down incessantly till about the middle of June, when the rivers swell to an immense height. The logs

then float down a distance of 200 miles, being followed by the gangs in pit-pans to disengage them from the branches of overhanging trees, until they are stopped by a boom placed in some situation convenient to the mouth of the river. Each gang then separates its own cuttings by the marks on the ends of the logs, and forms them into large rafts; in which state they are brought down to the wharves of the proprietors, where they are taken out of the water and undergo a second process of the axe, to make the surface smooth. The ends, which frequently get split and rent by the force of the current, are also sawed off, and then they are ready for shipping.—*Abridged from* SQUIER's *Notes on Central America.*

THE SEA DYKES OF HOLLAND.

THE total gain of land by dyking in the Low Countries is estimated by the recent Dutch author, W. H. Staring, at about nine hundred thousand English acres, or one-tenth the area of the kingdom. Most part of this is somewhat above low-water level, but the whole is subject to inundation in case of an accident. Such accidents have occurred from time to time. Ring dykes are constructed on a gigantic scale, to form a first and outer bulwark against the sea. These, however, gradually sink in the soft mud, and when raised by fresh constructions, the increased weight only sinks them lower. It is said that in some places they have gradually sunk to the depth of from sixty to a hundred feet. Thus the expenditure of time and labour has been much greater than appearances would lead one to suppose. It must also be borne in mind that there has been an enormous loss, chiefly of poor lands without much soil, owing to the encroachments of the sea and the neglect of certain dykes. There has also been a great loss by the removal of soil once gained.

The sea is constantly forming new banks at certain points of the coast, favourable for the deposit of sand and earth; and the stratum of sand with shells thus obtained, serves as the foundation for dykes. The instant such banks are above the low-water

level, reeds grow upon them, and much mud is entangled among the roots. In this way high-water level is reached, and then grasses grow, and the embankments are safe. These first embankments are constructed of sand and earth bound together by fascines and provided with sluices. The sluices are the most expensive part of the work, as they are constructed with piles, and are intended to be open at low water. The body of the dykes slopes outward very gently, but the crown is steeper. The height and thickness vary according to local circumstances of tide and wind, but they are generally from fifteen to twenty feet above high-water mark. Many of the principal dykes are strengthened by piles driven deeply down into the bed of the sea. Thus, along the coast of Friesland, where no dunes exist, the dykes are on piles for a distance of 150 miles, and these piles are tied together by cross timbers and iron clamps, the interstices being filled with stones. One of the dykes (the Great Helder) is about forty feet wide at the top, along which runs a good road. It slopes down 200 feet into the sea at an angle of 40°. At certain distances immense buttresses run out several hundred feet into the rolling sea. This gigantic artificial coast is entirely composed of Norway granite.

The soil thus preserved, though originally not above high-water level, will, if it do not sink or be accidentally injured, gradually acquire height by the effect of continued vegetable growth; but there is often a shrinkage and settling of the earth that more than counterbalances this gain. In most cases it is necessary to make use of wind-power, working pumps which lift the water to a higher level and into a channel by which it can be conveyed to the sea. Steam-engines are now very largely used for such purposes. In the drainage of the Lake of Haarlem, recently effected, the principal engine was of 500 horse power, and drove eleven pumps, raising altogether 120 millions of gallons per diem. The lake was about fifteen miles in length by seven in greatest width. It had long been in a dangerous state, but in December 1836 it burst its barriers and overflowed 20,000 acres of land at its southern extremity. The mischief

done was great, and it was felt that the time was come when the cause should be prevented. The work of enclosing the lake with a ring dyke was commenced in 1840, and lasted eight years; after which the drainage occupied five years, when the lands were sold. The cost of the operation was £764,500, and the loss to the State may be estimated at about £100,000—a result thought favourable. There cannot be a doubt that the existence or otherwise of a large extent of low flat land near the mouth of a great river must have influence on the adjacent coast. The force of the tidal wave, the direction in which it acts, the local currents, the configuration of the coast, the depth of water near shore, and the form of the bottom, are all affected by changes produced on the coast by way of embankment.—ANSTED: *Physical Geography*.

"DRYMAKINGS" IN HOLLAND.

A report by Mr. Thurlow, Secretary to the British Legation at the Hague, gives a description of the *polders*, or drained lakes, of which Haarlem-meer is the most notable example. It appears that after being pumped dry the area is cut up into parallelograms, which are frequently not much larger than an acre each, and are separated by primary canals. These drain the land in wet seasons and irrigate it in time of drought, as well as form a highway for the small boats which take the place of the English tumbrel or waggon. A certain number of parallelograms are formed into a group, and pump their superfluous drainage into transverse canals, which communicate with the main outlets to the sea. In one case there are no less than four canal systems with different levels, through all of which every drop of water must pass in order to reach the ring dyke which girdles the *polder*. This dyke is constructed in duplicate, with an intervening space of fifteen or twenty metres, and water-works are erected on its banks. These drained lakes do not afterwards gather to any great extent, and the rainfall is seldom excessive, being pumped out by ordinary windmills before the 1st May. The health of the "colonists," as the population may be called, is satisfactory, and the reclamation

answers financially. The draining of Haarlem-meer took nearly thirteen years, and cost about £1,000,000 sterling; but the outlay has been recouped by the sale of 42,000 acres. The recovery of the Zuyder Zee is seriously looked forward to; and this would throw all former undertakings into the shade. Amsterdam would then have an outlet to the German Ocean by the North Holland Canal, now in process of construction, and which is of such dimensions as to allow two men-of-war to pass each other at any point. During the last two hundred years, £300,000,000 have been expended for hydrographical purposes in the narrow tract of country, hardly as big as Wales and Yorkshire put together, lying between the Dollardt and the Scheldt; and Mr. Thurlow compares the Netherlands to a copyhold property, with Neptune as lord of the manor, whose fines amount to a million sterling per annum for repairs and superintendence.

MANUFACTURE OF TEAS IN CHINA.

Without entering minutely into the subject of the manipulation of black and green teas, it may be remarked that the method of treating each kind during the process of manufacture differs in some material points, and that this difference in manipulation is quite sufficient to account for the difference in colour. It is scarcely necessary to remark that both kinds of tea are gathered from the bushes in the same way, and are made from the same description of leaves—namely, those which are young and lately formed.

GREEN TEA.

When the leaves are brought in from the plantations they are spread out thinly on bamboo trays, in order to dry off any superfluous moisture. They remain for a very short time exposed in this manner—generally from one to two hours; this, however, depends much upon the state of the weather. In the meantime the roasting-pans have been heated with a brisk wood-fire. A quantity of leaves are now thrown into each pan,

and rapidly moved about and shaken up with both hands. They are immediately affected by the heat, begin to make a crackling noise, and become quite moist and flaccid, while at the same time they give out a considerable portion of vapour. They remain in this state for four or five minutes, and are then drawn quickly out and placed upon the rolling-table.

The rolling process now commences. Several men take their stations at the rolling-table, and divide the leaves amongst them. Each takes as many as he can press with his hands, and makes them up in the form of a ball. This is rolled upon the ratan-worked table, and greatly compressed, the object being to get rid of a portion of the sap and moisture, and at the same time to twist the leaves. These balls of leaves are frequently shaken out, and passed from hand to hand, until they reach the head workman, who examines them carefully, to see if they have taken the requisite twist. When he is satisfied of this, the leaves are removed from the rolling-table and shaken out upon flat trays, until the remaining portions have undergone the same process. In no case are they allowed to lie long in this state, and sometimes they are taken at once to the roasting-pan.

Having been thrown again into the pan, a slow and steady charcoal fire is kept up, and the leaves are kept in rapid motion by the hands of the workmen. Sometimes they are thrown upon the ratan-table and rolled a second time. In about an hour, or an hour and a half, the leaves are well dried, and their colour has become *fixed*—that is, there is no longer any danger of their becoming black. They are of a dullish green colour, but become brighter afterwards.

The most particular part of the operation has now been finished, and the tea may be put aside till a larger quantity has been made. The second part of the process consists in winnowing and passing the tea through sieves, in order to get rid of the dust and other impurities, and to divide the tea into the different kinds; known as twankay, hyson-skin, hyson, young hyson, gunpowder, &c. During this process it is refired, the coarse kinds once, and the finer sorts three or four times. By

this time the colour has come out more fully, and the leaves of the finer kinds are of a dull bluish green.

It will be observed, then, with reference to *green tea ; 1st*, That the leaves are roasted almost immediately after they are gathered; and *2nd*, That they are dried off quickly after the rolling process. It is almost unnecessary to mention that many of the "green teas" prepared for the English and American markets are coloured artificially, by roasting them along with a mixture of powdered gypsum and Prussian blue, which imparts to them a brighter and more uniform hue. About half a pound of this admixture is added to every hundred pounds of tea—the Chinese excusing themselves for the adulteration, "because the prettier colour pleases the eye of the foreigner, and takes the market more readily."

BLACK TEA.

When the leaves are brought in from the plantations they are spread out upon large bamboo mats or trays, and are allowed to lie in this state a considerable time. If they are brought in at night, for example, they lie untouched till next morning.

The leaves are next gathered up by the workmen with both hands, thrown into the air, and allowed to separate and fall down again. They are tossed about in this manner, and slightly beaten or patted with the hands, for a considerable space of time. At length, when they become soft and flaccid, they are thrown into heaps, and allowed to lie in this state for about an hour, or perhaps a little longer. When examined at the end of this time, they appear to have undergone a slight change in colour, are soft and moist, and emit a fragrant smell.

The next part of the process is precisely the same as in the manipulation of green tea. The leaves are thrown into an iron pan, where they are roasted for about five minutes, and then rolled upon the rattan-table.

After being rolled, the leaves are shaken out, thinly, on sieves, and exposed to the air out of doors. A frame-work for this purpose, made of bamboo, is generally seen in front of all the

cottages amongst the tea-hills. The leaves are allowed to remain in this condition for about three hours; during which time the workmen are employed in going over the sieves in rotation, turning the leaves, and separating them from each other. A fine dry day, when the sun is not too bright, seems to be preferred for this part of the operation.

The leaves, having now lost a large portion of their moisture, and having become reduced considerably in size, are removed into the factory. They are put a second time into the roasting-pan, for three or four minutes, and taken out and rolled as before.

The charcoal fires are now got ready. A tubular basket, narrow at the middle, and wide at both ends, is placed over the fire. A sieve is dropped into this tube, and covered with leaves, which are shaken on it to about an inch in thickness. After five or six minutes, during which time they are carefully watched, they are removed from the fire and rolled a third time. As the balls of leaves come from the hands of the roller, they are placed in a heap until the whole have been rolled. They are again shaken on the sieves as before, and set over the fire for a little while longer. Sometimes the last operation—namely, heating and rolling—is repeated a fourth time. The leaves have now assumed their dark colour.

When the whole has been gone over in this manner, it is then placed thickly in the baskets, which are again set over the charcoal fire. The workman now makes a hole with his hand through the centre of the leaves, in order to allow vent to any smoke or vapour which may rise from the charcoal, as well as to let the heat ascend, and then covers the whole over with a flat basket: previous to this, the heat has been greatly reduced by the fires being covered up. The tea now remains over the slow charcoal fire until it is perfectly dry; it is, however, carefully watched by the manufacturer, who every now and then stirs it up with his hands, so that the whole may be equally heated. The black colour is now fairly brought out, but afterwards improves in appearance. The after processes, of sifting, picking, and refining, are carried on at the convenience of the workmen.

It will be remarked, therefore, with reference to the leaves that are to be converted into black tea,—1*st*, That they are allowed to lie for some time spread out in the factory, after being gathered, and before they are roasted; 2*nd*, That they are tossed about till they become soft and flaccid, and then left in heaps, and that this also is done before they are roasted; 3*rd*, That after being roasted and rolled they are exposed for some hours to the air in a soft and moist state; and 4*th*, That they are at last dried slowly over charcoal fires.

With regard to the scenting of the finer and more expensive varieties of tea, it may be remarked that the various flavours are imparted by mixing the dried and finished teas with the undried flowers of such plants as the orange, jasmine, rose, gardenia, &c., and allowing them to lie till they have imbibed the necessary fragrance, after which the flowers are sifted out, and the teas carefully packed for the market. The length of time that teas retain the fragrance thus imparted varies with the nature of the flower employed; the olive fragrance evaporating in a year; the orange keeping for two or three years; and the jasmine and aglaia for five or even six years.—*Abridged from* FORTUNE's *Visit to the Tea Districts of China and India.*

PRESERVATION OF MEATS AND FRUITS.

THE property of organic substances to pass into a state of fermentation and decay, in contact with atmospheric air, is annihilated in all cases, without exception, by heating to the boiling point. Fresh animal milk, as is well known, coagulates, after being kept for two or three days, into a gelatinous mass. If fresh milk be heated daily to the boiling point, it may be preserved for an indefinite period. If a bottle be filled with grape juice and made air-tight, and then kept for a few hours in boiling water, or until the contained grape juice has become throughout heated to the boiling-point, the minute amount of oxygen contained in the air which entered the flask with the grape juice becomes

absorbed during the operation by the constituents of the juice, and thus the cause of further perturbation is removed. The juice does not now ferment, but remains perfectly sweet until the flask is again opened and its contents brought into contact with the air.

The knowledge of these properties, which are equally possessed by all other organic substances, has given rise to the most beautiful practical applications of them. Whilst in former times, during long voyages, mariners were confined to salt and smoked meats, which, in the long run, always proved injurious to the health of the crew and the passengers, and thousands of human beings lost their lives from the want of fresh aliments, which were even more essential in sickness, these dangers and discomforts become more and more rare at the present day. This is certainly one of the most important contributions to the practical benefit of mankind ever made by science, and for this we are indebted to the French chemist Guy Lussac.

At Leith, in the neighbourhood of Edinburgh, at Aberdeen, at Bourdeaux, Marseilles, and in many parts of Germany, establishments of enormous magnitude exist, in which soup, vegetables, animal substances, and viands of every description, are prepared and sent to the greatest distances. The prepared aliments are enclosed in canisters of tinned iron plate, the covers are soldered air-tight, and the canisters exposed to the temperature of boiling water. When this degree of heat has penetrated to the centre of the contents, which it requires about three or four hours to accomplish, the aliments have acquired a stability which, one may almost say, is everlasting. When the canister is opened after the lapse of several years, the contents appear just as if they were only recently enclosed. The colour, taste, and smell of the meat and vegetables remain quite unaltered. This valuable method of preparing food has been adopted by many persons in my neighbourhood, and other parts of Germany, and has enabled our housewives to adorn their tables with green vegetables in the midst of winter, and with dishes at all times which otherwise could be obtained only at particular seasons. This method of

preserving food will become of the greatest importance in provisioning fortresses, ships of war, and the like, since the loss incurred in selling of old stores and replacing them by new, especially with respect to meat, ham, &c., is far more considerable than the value of the tin canisters, which, moreover, may be repeatedly employed after being carefully cleansed.—LIEBIG: *Letters on Chemistry.*

THE SCIENCE OF COOKING FLESH-MEAT.

THE knowledge of the nature and properties of the several materials composing flesh, their relative value as food, and, above all, the action of heat upon them, is the foundation of all good cookery. The flesh of animals—that is, the lean, as distinguished from the fat—consists in great part of water, which constitutes about three-fourths of its weight. This *water* contains dissolved within it several substances of the highest value as food; hence the extreme desirability in all culinary processes of rendering the juice of the flesh, as this is termed, available for food, and preventing its escape and loss. Of the other constituents of meat, the most important is the substance which forms the chief part of the fibre of the flesh, and hence it is termed *fibrin.* Fibrin is quite insoluble in cold water, but is capable of being softened by long exposure to a degree of heat considerably below that of boiling water; but, on the contrary, it is rendered tough and hard by long-continued boiling.

Albumen, which is identical with the white of egg, is also always present in flesh. Its properties are very peculiar. It is capable of mixing readily with cold water, but when it is heated about 30° below the boiling temperature of water it coagulates, forming a solid mass, as seen in a well-boiled egg, but separating in thin flakes if the solution is weak.

The substance known as *gelatine* is also found, in very varying amount, in the flesh of animals. In lean meat, free from sinew, it is present to a very slight extent; but in the tendinous portions it constitutes a much larger proportion. It dissolves readily in

boiling water, and its solution becomes a jelly on cooling; it also constitutes the substances known as isinglass and the "prepared gelatine" of the shops. Gelatine exists also in large quantity in bones, forming from one-third to nearly one-half of their weight. Regarded as a nutritious article of food, its value was formerly very greatly overrated. At one time it was regarded as the most valuable of all the constituents of animal food; and by some of the theoretical men of the last century bone was regarded, from the amount of gelatine it contains, as even more nutritious than flesh. At the present time its value as food is by some theorizers utterly denied. Dr. Lankester, for example, would tell us that the gelatinous tissues of a calf's head or foot, or the jelly so grateful to the instinctive appetite of a convalescent, is perfectly valueless as an article of diet. The only foundation for this extraordinary statement consists in the fact that gelatine, although forming so large a portion of the animal structure, is not found in the blood, nor in milk, which may be regarded as a model food. The facts, however, that the life of dogs can be sustained for an indefinite period by feeding them on bones, and that gelatinous articles of food, when dissolved by the gastric juice of the stomach, form a liquid that cannot be distinguished from the product of the solution of the other ingredients of the flesh, are entirely overlooked by the advocates of this last scientific absurdity. The same reasoning, or rather want of it, would prove that milk is useless as an article of diet, because one of its chief constituents, casein, or curd, does not exist in the blood.

Such being the chief constituents of animal food, it may be asked what causes produce the differences that may be noticed in the several parts of the same animal? As far as regards the flesh itself, the fibres of the muscles are in some parts peculiarly firm and dense, in others the texture is finer and more open. Take the tongue, for example. In this the fibres are fine and much interlaced; consequently the organ is not only exceedingly palatable, but remarkably nutritive. In the heart, on the other hand, the structure is dense, and it is consequently not so readily digested.

The object of all culinary operations, as performed upon meat, should be to act upon each of the constituents of the flesh in such a manner as to render it most available for food, and most easily acted on by the digestive organs. Thus, the fibrin should be softened, the gelatine dissolved, and the albumen slightly but not firmly coagulated; whilst of the nutritious juice of the flesh, constituting the gravy of the meat, not a drop that it is possible to preserve should be suffered to escape. Let us consider the effects that are produced when a piece of flesh, such as a steak, is presented to the fire, as in the operation of broiling. The first effect is the coagulation of the albumen in the outer layer. This immediately renders the side presented to the heat impervious to the passage of the juice of the flesh, or, as we now term it, the gravy. The second effect is the contraction of the fibres, which tends to press out the gravy. To prevent this latter effect, therefore, the skilled cook turns the opposite side to the fire immediately after the first has been rendered impervious by the coagulation of the albumen; and by constantly repeated turnings the escape of the juice of the flesh is entirely prevented. In this way the heat is allowed gradually to permeate the flesh, which is everywhere thoroughly cooked, without the fibrin being hardened by being overheated, and a succulent, gravy-teeming, tender steak is the result. If, however, the steak is cut too thin, or if it is overheated, the fibrin is dried up, and a horny indigestible mass results; or if during the operation a fork be thrust in, apertures are made through which the gravy can escape, and the value of the food, as well as its palatable character, will be greatly deteriorated.

One of the most wasteful processes of preparing meat is that known as *salting*. Let us review this subject somewhat in detail. A fleshy joint of meat, such as an aitch-bone of beef, is rubbed with salt. This substance has a strong attraction for water, and it consequently causes a very large proportion of the juice of the flesh to pass out, the salt dissolving in it, and so forming "brine." By the loss of this fluid the nutritive properties of the meat are greatly impaired; in fact, they are lessened to such an extent that

salt meat is not able to support life for any lengthened period of time. The brine, though containing so large a proportion of the most valuable ingredients of the flesh, is perfectly useless from its saltness, and is consequently thrown away. Not only is the process of salting injurious by causing the loss of nutriment, but it also hardens and corrugates the remaining fibre, rendering it less easily masticated and less digestible.

Doubtless many English cooks would reply to this accusation, of what may be termed a sinful waste of food, that beef must be salted preparatory to boiling. Let us beg them to try an experiment. Suppose, instead of salting the beef, they place it in a vessel with the smallest quantity of water that will cover it, and place it by the side of the fire so that it will be some two hours or more before it approaches the boiling-point—which it should never be allowed to reach—and let them conclude the cooking at a lower temperature than boiling; in fact, instead of boiling salted meat, let them stew a joint of fresh beef, by which they will obtain a tender, nutritious, palatable meat, and a liquid that can be used with advantage as soup.

The absurd prejudice in favour of the wasteful plan of salting beef prevails in no country but our own. Even we are inconsistent in our absurdity; we do not salt mutton, veal, or lamb previously to boiling, and we only salt beef because other foolish persons have done so before us.—*Abridged from "The Queen."*

CASHMERE SHAWLS.

FINEST of all woollen textures, and most exquisite in workmanship, is the Indian shawl. Uniting richness of design with freshness of colouring, it has no rival in the world. It is not only the most splendid tissue ever wrought by the hand of man, but it is also the most solid and most durable, whether it adorns the shoulders of a European beauty or girds the waist of an Eastern potentate.

The seat of this industry is the Vale of Cashmere, celebrated

for "its roses, the brightest that earth ever gave," the chosen theme of the poet and the painter. In this favoured spot and its surrounding mountains the industrious inhabitants are principally employed in laborious manufacture. The Cashmere shawl is woven from the wool of the Thibet goat; the material for the shawls (which is carried to Cashmere) is found next the skin of the animal, and is surpassingly soft and silky. When employed for fabricating shawls, the wool is first made over to the women to spin—a difficult and costly operation. It is next passed to the dyer, to give it its unalterable colours; then delivered to the weaver, who sets up his simple frame, and weaves, after the pattern given him, the segment of the shawl allotted for his task. The shawls are all made in separate pieces, and when the portions distributed to the different weavers are finished they are given to skilled workmen called *ra-fu-gar*, to whom is assigned the difficult duty of joining the segments together. These seams, however, generally require to be re-sewn in Europe before the shawl is offered for sale. The flowers and arabesque patterns are worked in by the hand. When finished the shawl is well cleaned and covered with a strong paste, principally made from rice. The whole completed, it is delivered to the purchaser.

Shawls were formerly made in pairs, but since European dealers have invaded Cashmere more than two are made from the same pattern.

If destined for Europe, the shawl has to be disencumbered of its provisional dressing. For this purpose it is washed in the river flowing from the Lake of Cashmere, whose waters are reputed to preserve the colours—a property attributed to the aromatic plants growing on its banks. A sheet of paper is laid between each fold of the shawl. It is enclosed in four or five envelopes, and packed with the utmost precaution.

So delicate and complicated a work can only be accomplished by workmen versed in it from infancy, and who, living upon a handful of rice, are satisfied with moderate wages. The best workmen scarcely earn more than from three to four cents a day. The low price of labour will always render Europe tributary to

Asia for this luxurious production. A shawl which costs 400 dollars at Cashmere, or at Umritzur in the Punjaub, where these shawls are also fabricated, could not be made for less than from 5000 to 6500 dollars by European workmen. The material only enters into 20 per cent. of the cost. Hence many French manufacturers have formed establishments at Cashmere and Umritzur, where shawls are made by native workmen; but in too many instances they have introduced their own designs, which have changed the national character of the shawl—and often in these cases the beautiful tissue is concealed beneath a mass of embroidery.

Shawls of inferior quality are also made at Loodiana, where this industry was introduced by a colony from Cashmere, recruited every year from the valley. The colours of those made at Loodiana are very solid, and bear constant washing. They are wanting in brilliancy of tints, consisting principally of brown, black, dark bottle-green, and indigo blue. The colours most prized are a dull yellow, shades of amaranth, and, most brilliant of all, a kind of rose pomegranate of the finest thread, used only in shawls of the finest quality. The favourite colour in India is a bright copper green: it is false, but very brilliant and costly, and is chiefly employed where palms are introduced into the design. Another shade of the same colour is used for the warp of the finest shawls, as is also turquoise blue—a most costly colour.

At Loodiana the workmen are seated three together at the same strip, in front of a cylinder upon which the warp is rolled. Each has at least fifty shuttles. The chief sits in the middle and guides the other two. In one pair of shawls is six hundred days' work: they would cost at Loodiana, if of the finest quality made, about 100 dollars. The white shawls with green palms are the coarsest. These Loodiana shawls are heavy, the palms stiff and ungraceful, and they are destitute of the softness so admired in Europe; but this they gain, in a great degree, by wear and washing. From their cheapness, Cashmere cannot contend with Loodiana in the Indian market. What the Indian produces by years of manual labour, the European now obtains in a short time

by means of machinery. Shawls are made in the Jacquard loom by workmanship the most intricate and complicated.

Though inferior in softness to its Indian rival, the French shawl is the most beautiful and elaborate tissue machinery ever produced. It is also made of the down of the Thibet goat, originally introduced from Russia, at great expense, by Monsieur Ternaux, who produced in 1810 the first Cashmere shawl ever manufactured in France. The weft is entirely of wool, worked like carded wool, to produce a smooth tissue; but in the warp is introduced a thread of fine silk, called *organsine* (for which cocoons of the first quality are reserved), to give it sufficient stability to weave. The French shawl is finer and more cloth-like to the touch than the Indian, and smoother in surface, from its more perfectly spun yarn, which is free from the knotty irregularities of the Indian web. Yet, notwithstanding these improvements, the French shawl never falls in the soft elegant folds of the true Cashmere.

France has only three centres for the manufacture of shawls—Paris for the finest quality, Lyons, and Nîmes. The greater number sold at Paris are woven in Picardy, at Fresnoy-le-Grand, and Rohain. The Paris manufacturers have always, by their taste and inventive genius, maintained their superiority in this manufacture. It is there that the use of the Jacquard loom has been brought to the greatest perfection, and its workshops of design have the highest reputation. The pattern being "read," as it is called, on the Jacquard cards, the workman has given to him the warp, ready dyed and prepared, and the materials necessary to form the weft. When woven, the shawl is trimmed, washed, and dressed. Since the introduction of European capital and industry the Indian shawl has much diminished in price, and has become a formidable rival to the Paris shawl, which formerly replaced the more costly production of the East.

The two kinds may always be distinguished from each other by one marked difference. In the French shawl there is a great loss of material, because the wool passes the whole width of the warp, only to appear where it forms the pattern, and being seen

behind in loops, or *brides*, as they are termed, which are cut away, when the tissue is finished, to diminish the weight of the shawl. The Indian shawl, on the other hand, is woven like a kind of tapestry, every thread following only the outline it has to form, being fastened by knots on the wrong side. These remain in the state the workmen left them, adding much to the solidity and strength of the shawl, which therefore never ravels out.

But the great merit of the Indian *cachemire* consists in the harmony and effect produced from the proper distribution of colour and the rich invention of their patterns: these give them an evident superiority over the French shawls, which are chiefly distinguished by their well-chosen designs and the perfect regularity of their weaving—equally apparent both in the ground and in the border. These merits do not appear in the Indian shawl, where the execution of the pattern is more or less imperfect, according as the strips have been made by more or less competent workmen. The numerous seams required in these shawls to unite the different pieces that compose them offer also an ungraceful aspect, scarcely consistent with the *élégantes* they adorn. But as these faults serve to give them a special character, they become often a "quality" instead of a defect in the eyes of the purchaser. It must always be borne in mind that the Cashmere wool is the most delicate and difficult of all tissues to work, and that the Eastern natives, by their success in weaving it, have earned the reputation of being the most patient and most skilful weavers in the world.—*Abridged from "The Queen."*

PEARLS AND PEARL-FISHERIES.

THE pearl, so highly prized as a gem, is the product of certain marine and fresh-water shell-fish. Most of the shell-fish or molluscous animals which are aquatic are provided with a fluid secretion, with which they line their shells, and give to the other-

wise harsh granular material of which the shell is formed a beautifully smooth surface, which prevents any unpleasant friction upon the soft and tender body of the animal. This secretion is evidently laid on in extremely thin transparent films, which, in consequence of such an arrangement, have generally a beautiful iridescence, and form in some species a sufficient thickness to be cut into useful and ornamental articles. This material, called *nacre* by zoologists, is the well-known *mother-of-pearl* of commerce. Besides the pearly lining of the shells, detached and generally spherical portions of the nacre are found on opening the shells; and there is reason to suppose these pellets are the result of accidental causes, such as the intrusion of a grain of sand or other substance, which, by irritating the tender body of the animal, obliges it in self-defence to cover the cause of offence; and, as the secretion goes on regularly to supply the growth and wear of the shell, the included body gets its share, and thereby continues to increase in size until it becomes a *pearl*. The Chinese avail themselves of the knowledge of this fact to compel one species of fresh-water mussel, *Unio hyria*, to produce pearls. In order to do this they keep the unios in tanks, and insert between the shell and the mantle or secreting organ of the animal either small leaden shot or little spherical pellets of mother-of-pearl. These are sure to receive a regular coating of the nacreous secretion; and after a time look like pearls formed under ordinary circumstances.

The most famous pearls are those from the East; and the coast of Ceylon has from the earliest times been the chief locality for pearl-fishing. They are, however, obtained now nearly of the same quality in other parts of the world, as Panamá, St. Margarita in the West Indies, the Coromandel coast, the Sooloo Islands, the Bahrein Islands, and the islands of the Persian Gulf. The pearls of the Bahrein fishery are said to be even finer than those of Ceylon, and they form an important part of the trade of Bassorah. These, and indeed all the foreign pearls used in jewellery, are produced by the pearl oyster—*Avicula margaritifera*. The shells which yield the Ceylon, Indian, and Persian ones, are sometimes

a foot in diameter, and usually about nine inches. Those of the New World, although the shells are smaller and thicker, are believed to be of the same species.

The chief locality of the Ceylon fishery is a bank about twenty miles long, ten or twelve miles from shore, and opposite to the villages of Condatchy and Aripo on the northern coast. The season of the fishery lasts about three months, commencing at the beginning of February, and is carried on under Government regulations. The boats employed are open, and vary in size from ten to fifteen tons burden. They put out at night, on a signal-gun being fired from the port of Aripo, and make for the Government guard-vessel, which is moored on the bank, and serves the double purpose of a guard and a light-ship. The divers are under the direction of a manager, and they are chiefly Tamils and Moors from India. For each diver there is provided a diving-stone, weighing about thirty pounds, which is fastened to the end of a rope long enough to reach the bottom, and having a loop made for the man's foot; and, in addition to this, a large net-work basket, in which to place the pearl-oysters as he collects them. These are hung over the sides of the boat; and the diver, placing his foot in the loop attached to the stone, liberates the coils of the rope, and with his basket rapidly descends to the bottom. To each boat there is usually allotted a crew of thirteen men and ten divers—five of whom are descending while the others are resting. This work is done very rapidly, for, notwithstanding the stories to the contrary, the best divers cannot remain longer than eighty seconds below, and few are able to exceed sixty. The greatest depth they descend is thirteen fathoms, and the usual depth about nine. When the diver gives the signal by pulling the rope, he is quickly hauled up with his net and its contents. Accidents rarely happen; and as the men are very superstitious, their safety is attributed to the incantations of their shark-charmers, performed at the commencement of the fishing. Sir Emmerson Tennent, however, attributes the rarity of accidents from sharks, usually so abundant in tropical seas, to the bustle and to the disturbance of the waters during the fishery frightening away these dreaded

creatures. The divers are sometimes paid fixed wages; others agree for one-fourth of the produce.

When a boat-load of oysters has been obtained, it returns to shore; and the cargo, sometimes amounting to 20,000 or 30,000, is landed and piled on the beach to die and putrefy, in order that the pearls may be easily found. The heaps are formed in small walled compartments—the walls being about two feet in height. Several of these compartments surround a small central enclosure, in which is a bath, and they slope towards the bath, and are each connected with it by a channel, so that any pearls washed out from the putrefying mass by the rain may be carried into the bath. When the animals in the shells are sufficiently decomposed, the washing commences, and great care is taken to watch for the loose pearls, which are always by far the most valuable. The shells are then examined, and if any attached pearls are seen, they are handed over to clippers, who skilfully remove them. Such pearls are used only for setting; whilst the former, being usually quite round, are drilled and strung, and can be used for beads, &c. The workmen who are employed to drill the pearls also round the irregular ones, and polish them with great skill.

The method of holding the pearls during these operations is very curious: They make a number of holes of small depth in a piece of dry wood, and into these they fit the pearls, so that they are only partly below the surface of the wood, which they then place in water. As it soaks up the water and swells, the pearls become tightly fixed, and are then perforated, &c. These operations are all carried on on the spot. The pearls vary much in size; those as large as a pea and of good form and colour are the best, except unusually large specimens, which rarely occur. The smaller ones are sorted into sizes—the very smallest being called *seed-pearls*.

During the occupation of Britain by the Romans, this country became famous for its pearls, which were found in the fresh-water mussel of our rivers (*Alasmodon margaritiferum*). Generally the pearls of this mollusc are small, badly-coloured, and of little value; but occasionally they occur of such beauty as to rival

those of the pearl-oyster. The fishing for pearl-mussels is by no means so dangerous or troublesome as for pearl-oysters. Usually they are found in the beds of streams shallow enough to wade in, and so clear that they can be seen at the bottom. If too deep to be removed by the hand, they are easily captured by putting a stick between their gaping shells, which instantly close upon it, and can thus be brought to the surface.

Very fine river pearls, known as Bohemian pearls, are found in the rivers Moldau and Wottawa. There is also a fresh-water pearl-fishery in Bavaria, where the river Iltz yields at times very fine specimens. Even the most inferior pearls have a market value; for pearls can only be properly polished with pearl-dust, and the inferior sorts are powdered for the purpose of rounding and polishing the finer ones.—*Compiled.*

PAPER AND PAPER-MAKING.

Paper has come to play such an important part in the social, intellectual, and commercial relations of mankind, that even a temporary stoppage of the supply would amount to a calamity. It is almost the only article manufactured for which no convenient substitute could be obtained. Our woollens, linens, and cottons, could stand substitute for each other; but what substance is there that would serve so many purposes as paper, or serve them so well? It is the vehicle of written thought between nations and individuals, and without it the art of printing could not have been made available, except in a costly, and consequently limited, way. Viewed in that light, it may be said that paper has contributed more to the advancement of the human race than any other material employed in the arts. As an article of manufacture and commerce, it occupies an important place, giving employment to many thousands of persons, and utilizing materials that would otherwise be useless, or worse.

The history of paper, so far as it is known, is familiar to most people. Paper had its origin in Egypt, where the bark of the

papyrus—a reed growing on the banks of the Nile—was formed into sheets for the priests to write upon. The thin slips of bark were arranged in transverse layers on a table, and subjected to pressure, under which the bark became cemented by its own gum. The "sheets" of papyrus formed in that way were quite flexible, and, before the invention of bookbinding, were usually made up in the form of rolls. It is not known when nor by whom the art of making paper from *pulp* was invented; but it is considered probable that the credit of the invention belongs to the Chinese, who, it is stated, were familiar with the art about the beginning of the Christian era. The first materials used were the bark of various trees, portions of bamboo stems, and cotton. Then cotton was used alone. In the seventh century, the Arabians learned from the Chinese how to make paper of cotton. From China the art was carried into Spain, and the Moors discovered that paper could be made of hemp and flax as well as of cotton. Spain communicated the art to France and Holland, and thence it reached Britain.

The first paper-mill mentioned as existing in this country was erected in Hertfordshire by Mr. John Tate, about the year 1490. Royal patronage was conferred on Mr. Tate for his enterprise, as appears from two entries in the Household Book of Henry VII. In 1588, a German named Spielman established a paper-mill at Dartford, for which he was knighted by Queen Elizabeth, who also granted him a license "for the sole gathering for ten years of all rags, &c., necessary for the making of such paper." Mr. Tate's paper-mill must by that time have stopped, else it is unlikely that a monopoly would have been given to Spielman. In the course of the fourteenth century, the Germans carried the art of paper-making to great perfection; but, realizing the value of retaining the trade in their own hands, they kept their processes a profound secret. Even so late as the sixteenth century, the Dutch prohibited, under pain of death, the exportation of moulds for making paper. This secretiveness on the part of the people from whom it is supposed we acquired a knowledge of the art, tended to retard its progress in this country; and up till a com-

paratively recent period only the coarser kinds of paper were made. The first patent for paper-making in Britain was granted in 1665 to Mr. Charles Hildeyerd, and was described as being for "the way and art of making blue paper used by sugar-bakers and others." The second was granted in 1675 to Mr. Eustace Barneby, for "the art and skill of making all sorts of white paper for the use of writing and printing, being a new manufacture, and never practised in any way in any of our kingdoms or dominions." In 1680, Mr. Nathaniel Bladen patented "an engine method and mill whereby hemp, flax, lynnen, cotton, cordage, silk, woollen, and all sorts of materials may be made into paper and pasteboard." Five years later, Mr. John Briscoe claimed to have effected great improvements in the manufacture of paper, and took out a patent for "the true art and way for making English paper for writing, printing, and other uses, both as good and as serviceable in all respects, and especially as white, as any French or Dutch paper."

In Scotland, the manufacture of paper was begun towards the close of the seventeenth century. On the 19th August 1695 a company was formed in Edinburgh "for manufacturing white writing and printing papers." In 1709, a paper-mill was built at Valleyfield, Penicuick, by Mr. Anderson, the Queen's printer in that year. This mill is still in operation, and by successive extensions has become one of the largest establishments of the kind in the country. A comparison of the Paper Trade Directory for the year 1860 with that for the year 1868, shows that while the number of mills in England and Ireland has been decreasing, there has been an increase in the number of mills in Scotland. There were 359 mills in England in 1860, and there are 293 this year; for Ireland the figures are 35 and 21 respectively; and for Scotland, 54 and 57;—that is, a reduction of 19 per cent. has taken place in the number of English mills, of 40 per cent. in the number of Irish, while the Scotch have increased about 6 per cent.

No material has yet been discovered to supersede the use of linen and cotton rags in making the finer qualities of paper.

Many attempts have been made to find other kinds of fibre that would be equally suitable; and the list of substances which have been subjected to a trial is an exceedingly curious one. Up till the year 1857, upwards of two hundred patents had been taken out in this country for the protection of inventions of this kind, and they relate to about fifty varieties of fibre. The list includes asbestos, bean-stalks, clover, dung, gutta-percha, heather, moss, nettles, peat, sawdust, sea-weed, thistles, and tobacco-stalks. The demand for paper has always threatened to exceed the supply of rags, and hence the desire to find a substitute or auxiliary. About fifteen years ago, many experiments were made both in this country and on the Continent, with the view of discovering some material for making paper that would give more satisfactory results than any of the auxiliaries to rags previously introduced.

The material that has come nearest to answering the requirements, of anything that could compete with rags, is "esparto grass," a plant obtainable in great abundance on both the European and African shores of the Mediterranean. The capabilities of esparto were discovered to some extent in 1839, but the plant did not attract much attention until 1862. Mr. Routledge, of the Enysham paper-mills, near Oxford, had made some experiments with the fibre about the year 1856, and succeeded in discovering a more useful, effectual, and economical mode of treating it than any of those who preceded him in the research. About ten years ago, he began to make printing-paper from esparto exclusively; but it was only when his productions were shown at the Exhibition of 1862 that the value of his discoveries was fully realized. Esparto now holds a prominent and important position in the trade. Used alone, or with a small admixture of rags, esparto supplies the entire newspaper press of this country, and is extensively used in the production of other varieties of paper.

The application of machinery to the manufacture of paper is of recent date. Both in preparing the pulp and making the paper, the appliances used by the early paper-makers were of the simplest

kind, as may be gleaned from the following account of the mode of working practised in the mills of Mid-Lothian in the early years of this century:—The rags, after being thoroughly washed and bleached, were, while still wet, laid in heaps and covered over with sacking. In that way they were allowed to ferment for about a week, when they were taken out and cut into small portions by means of a sharp hook. They were next placed in large mortars made of oak, and there pounded with iron-shod rods kept in motion by either wind or water power. So slow was this process of pulping, that eighty pairs of stamps produced only one hundredweight of pulp a day. Even then, the work was so imperfectly done that the stuff had to be pressed into boxes, and allowed to "mellow" for several weeks. After that it had to be subjected to a series of beatings in the mortars before it was ready for use. The pulp was next placed in a "vat," along with a certain quantity of water. The fibrous matter was held in suspension by the liquor being constantly stirred by a revolving frame or series of wooden arms.

In making paper by the hand process (now almost extinct) the order of operations is briefly this:—The "dipper," or "vatman," takes a frame-work covered with wire-gauze, and dipping it into the vat, takes up a quantity of pulp sufficient for one sheet—the size of the sheet being determined by the size of the "mould," and the thickness by the depth of a movable ledge placed round the wire. The water soon drains off, leaving the pulp resting in an even layer on the wire. Another workman, designated a "coucher," takes the mould and transfers the pulp to a piece of felt or woollen cloth. Usually two moulds are employed, so that while the "coucher" is emptying one, the "vatman" is filling the other. The "layer" deposits the successive pieces of felt with their delicate burden in a pile; and when a certain number of sheets are thus arranged, they are taken to a press which forces out all the superfluous water, and gives a degree of firmness and solidity to the paper. The felts are then removed, and the paper pressed by itself. The paper, after being pressed, is hung on hair-ropes to dry. When dry,

it is sized, by being dipped into baths of size-liquor; after which it is again hung up. The paper is finished by being pressed between hot iron plates.

The first important mechanical contrivance introduced into the trade was the pulping-engine, invented in Holland about the middle of last century. The tedious method of fermenting the rags and bruising them in a mortar was superseded by this machine, which, in its present improved form, reduces the fresh rags to pulp in a few hours, and is capable of comminuting five or six tons a week. Though the means of producing a vastly increased quantity of pulp were thus provided, many years elapsed before any successful attempt was made to perform the work of the vatman and coucher by machinery. While mechanicians of world-wide fame were racking their brains to find out a system of paper-making machinery, Louis Robert, a humble clerk in a paper-mill at Essonne, was quietly studying the subject, and one day excited the wonder of his employers by producing for their inspection a working model of a machine which was capable of producing from the pulp webs of paper of any length. The model was a tiny thing, from which the paper came forth no wider than a piece of tape. A machine of larger dimensions was made and patented; and when the invention came under the notice of the Government, the ingenious author of it was liberally rewarded. The paper-making machine is one of the most ingenious and wonderful contrivances employed in the arts, and has been a chief cause in the creation of that cheap literature which has done so much to make the present century a remarkable era in the history of human progress.—*Compiled from Industries of Scotland.*

DECAY AND PRESERVATION OF BUILDING-STONES.

Stones of all kinds are more or less injured by long exposure to the vicissitudes of the weather; and in considering the causes of decay, and the best method of keeping back decay as long as pos-

sible, the chemical composition and state of mechanical aggregation of the rock must always enter into the calculation.

It is certain that the causes of decay are partly chemical and partly mechanical; and of these the latter include (1) the action of rain-water, either in rubbing away by friction or in dissolving parts of the stone; (2) the expansion of the moisture, and consequent disintegration of the stone by the action of frost. The former include (*a*) the decomposition produced by acids, and the chemical reactions that take place in stones exposed to the air after being long in the earth; (*b*) the efflorescence produced by the acids or alkalies in the air, on certain ingredients of the stone. All these deserve careful consideration, and all depend on the essentially porous and absorbent nature of all stones, which is proved by experiment, and which varies in every kind of material, and, indeed, in almost every hand specimen of similar material that is examined.

It is chiefly, if not entirely, by capillary attraction that water is sucked into the substance of stones; and there are, of course, definite limits to this attraction, though they are not much affected by the mechanical position of the stones. Thus, in a stone, of whatever kind, without distinguishable grain, or any laminated structure that one can detect, water would enter almost as rapidly and as far from below upwards, or from an exposed vertical face inwards, as from above downwards. Together with the water the substances contained in it might also enter, although these would be left behind near the surface. But when afterwards evaporation takes place from the surface, or in other words, when the stone dries after being wetted, it is only the pure water that passes off. Thus the foreign substances are left behind, and produce their due effect in time.

Rain-water, especially in towns, contains both carbonic acid gas and ammonia; and, however small the proportion may be, it is certain that every material liable to attack from these substances will ultimately yield more or less to their action. Thus, even in granite, especially when the felspar contains soda instead of potash, the silicates become ultimately decomposed and the

felspar destroyed by the constant action of rain-water. It is clear that when the felspar is gone the rock will soon become rotten and disintegrated. But if granite is thus destroyed, much more so are sandstones with calcareous cements, and limestones.

Nor does a London atmosphere contain only carbonic acid gas and ammonia. Owing to the quantity of coal burned, and the impurity of the coal, there is always a certain proportion of sulphurous acid in the air, and this becomes dissolved in the rain as it falls, and is extremely active, rapidly affecting the carbonates of lime, especially those varieties that are not crystalline. When, then, we consider the effect of the action of carbonic acid on the moistened carbonates, assisted by the occasional dilute sulphuric acid, and remember that this action is actually going on almost every day, with every change of weather, it is no wonder that the surface of the stone, freshly bruised by the action of the tool in bringing it to a face, and deprived of the only protection nature is able to give, should very soon show signs of injury, and that a rapid disintegration and destruction should take place.

The mere disintegration of a stone by the action of acid vapours would, however, be slow, except in certain cases, were it not for the combined action of heat and cold, and the consequent alternate expansion and contraction of the moisture contained in it. And this result is obtained in its maximum when the stone is so placed that the moisture, following the planes of stratification, is concentrated nearest the surface; which will happen when the stone is placed, not in the way in which it lies in the bed, but at right angles to this natural direction. As all stones, except granites, have some planes of stratification or cleavage—and even granites and basalts occasionally peel in concentric layers—it is clear that great care should be taken by the builder to place all stones as nearly as possible in their proper position.

When stones have been properly placed, the effect of weather may still be seen, but it is only distinguished by the gradual removal of the softer material and the part of the stone most easily acted on. This may, or may not, end in the final disintegration of the material; for some stones hold together soundly

enough long after they have been pierced through with holes and have lost all chiselled and projecting portions. Too much attention, then, cannot be paid to the mode in which stones are laid; and this remark applies to the whole group of freestones, but especially to the sandstones and limestones employed in the main walls of buildings, and most especially to those selected for ornamental work of any kind. So important is it to attend to the action of the weather on these parts, that it has been found to repay the cost to shelter the upper surface of such stones by lead or slates, where it is possible, so as to prevent water from resting upon them. As, however, a south-west exposure in our climate involves the constant beating of rain on the surface of stones thus placed, it is impossible to shelter the whole, and we are sure to find out in time the weak parts, by watching the change produced by the action of weather.

The injuries that take place in absorbent stones from chemical reactions are not so easily traced as the foregoing, but are not for that reason less real than those occasioned by the solvent and mechanical action of water and acids. Thus the various substances accidentally present in stone—those, namely, that are not essential to its composition—may become changed by the chemical action of salt contained in the absorbed water, and in consequence of this may injure the stone and increase its tendency to decay. Perhaps there is no cause of injury of this kind so great as that produced by an efflorescence of crystals, generally nitrates of potash and soda, the consequence in some measure of the organic contents of the stone. Whatever the cause may be, it is certain that many stones suffer from this efflorescence, especially those forming walls constantly damp and shaded from the sun. Loamy clays, places where sea-sand has been used, or where salt can in any way have been absorbed, and stones in which an unusual quantity of organic matter is present, are liable to this cause of mischief.

Whatever be the immediate cause of the destruction or disintegration of stones, it may generally be traced to the absorption of moisture; and thus any contrivance that will check the admission of water by removing it from contact with the undefended

sides of the stone, will be the most likely to succeed in preserving the material from decay. Many such contrivances have been proposed, all of which may be considered to involve some one of the following principles: (1) the covering up the surface of the stone by means of some animal, vegetable, or mineral oil plastered upon it; (2) the coating of the face of the stone by some insoluble mineral substance deposited upon it; (3) the defending the pores of the stone by causing them to absorb a chemical solution, which, on the application of another solution, becomes decomposed and deposits within the stone an insoluble coat.

A coat of paint on stone, by preventing the absorption of water at the surface, preserves stone so long as the paint remains undecomposed. Not only is this very unsightly, but it can only last a very short time. In London the time hardly amounts to three years, even under favourable circumstances. After that the paint peels, and must be renewed. The injection of oily and fatty matters acts in the same way, and lasts only a little longer. There is, however, no doubt that in some cases, where the exposure is not severe and the treatment has been adopted before the smallest commencement of decay or the least absorption of moisture had taken place, the result has been such as to secure the stone for so long a time that the result was thought to be permanent. For important buildings, intended to last for centuries, such treatment is, however, certainly useless, as it can only stave off the evil day for a time comparatively very short.

About twenty years ago, a German chemist, Professor Kuhlmann, applied fluid silicate of potash, obtained by dissolving flints in caustic alkali with the aid of water at a very high temperature, to harden chalk and porous stone. Three applications were considered sufficient. Although successful in the laboratory, this method failed when applied to buildings, because a dry atmosphere is needed during the whole period of hardening.

Not long after this suggestion had been made in Germany, Mr. Frederick Ransome of Ipswich, while manufacturing fluid silicate of soda on a large scale, repeated Professor Kuhlmann's experiments; and observing the cause of failure, attempted to fix the

solution when absorbed into the stone, by inducing it to absorb another solution, which should act by double decomposition, thus leaving an insoluble deposit within the substance of the absorbent stones on which it was desired to act. He found that by a weak acid solution he could set free the silica; but in that state the deposited mineral had no cohesion. Following up, however, the application of the fluid silica by a dose of chloride of calcium (muriate of lime —a waste product in chemical works), it resulted that the chlorine parting from the calcium attacked the soda of the silicate, forming common salt, which is easily dissolved away; while the silicic acid set free and combining with the lime formed with it silicate of lime. This mineral is nearly insoluble, very hard, and adheres with great tenacity to foreign substances—as is illustrated in common mortar. Silicate of lime thus formed resists carbonic acid and dilute sulphuric acid, and is little affected by any of the common alkalies or ammonia.

The effect of this treatment on stones that have not already been inserted into buildings has been very favourable, and they appear to have stood without decay under exposures sufficient to produce much injury on the same stone unprotected. Applied on a large scale to buildings that have already shown symptoms of decay, the result is less satisfactory; but years must elapse before a very decided opinion can be given on the process. Portions of the decaying magnesian limestone of the Houses of Parliament, and parts also of Westminster Abbey, have been subjected to the process, besides many buildings in London and elsewhere. The state of these will enable us after a time to know the real value of Mr. Ransome's discovery.—*Abridged from* ANSTED's *Applications of Geology.*

WINE.

WINE is the fermented juice of the grape, pure and simple; and if anything else has been added to it, the resulting liquid is not, strictly speaking, wine. Such a definition would, however, necessarily exclude the greater number of beverages drunk in Great

Britain under the name of *wine;* but as this would be practically inconvenient, we may extend the above definition so as to include in it all fermented liquids the basis of which is the juice of the grape, either pure or with such additions only as are believed to improve the durability of the wine.

This limitation would divide wines into two classes;—the first consisting of pure, natural wines; the second, of all fortified wines. It must, however, exclude entirely all compounds of which grape juice forms but an unimportant ingredient, or that contain no grape juice at all; such as some of the vile decoctions manufactured at Hamburg, and imported to this country under the name of Elbe Sherry and Port; and also the different beverages known as British wines.

Grape juice consists essentially of an aqueous solution of grape sugar, fruit sugar, tartaric and malic acids, partly free, partly in combination with potash, vegetable albumen, and mucilage; sometimes a small quantity of an essential oil (imparting a peculiar flavour, as in the muscatel grape), together with a small amount of mineral substances, chiefly chloride and sulphate of potash, and phosphate of lime. The skins and seeds of the grape contain albuminous substances, colouring matter, tannin, and a kind of fat; substances which are, under certain conditions, dissolved during fermentation, and which in their turn produce certain notable effects upon the wine.

For the purpose of wine-making the grapes are first crushed, either by being passed between rollers or by being trodden by men. The pulpy mass thus produced is then placed in powerful presses, by means of which the juice is separated from the greater part of the skins and seeds; and this expressed juice is called *must*. When white wine is to be made this juice only is taken. In the preparation of red wine, however, the skins and seeds are allowed to remain in the juice for from three to twenty days before pressing; since the juice even of red grapes would otherwise yield a white wine, the colour being imparted to the wine by the skins.

The *must* is now put into large vats or casks, and there left.

Soon it becomes turbid and evolves carbonic acid; and at the same time the growth of a peculiar kind of fungus—the yeast plant—may be observed in it. The *must* has begun to ferment. In order to start the fermentation, the access of air to the juice is essential; but fermentation, once set up, goes on even if atmospheric air be entirely excluded. The development of the yeast plant requires the presence of a nitrogenous as well as of a non-nitrogenous substance, the first of which is supplied by the vegetable albumen, the second by the sugar. During the growth of this fungus the albuminous substance becomes absorbed, and is made insoluble, while the sugar is in great part resolved into alcohol and carbonic acid. Fermentation, then, is probably nothing more than a vital process of the above-named fungus, by virtue of which it absorbs the sugar, converts part of it into cellulose, constituting the cellular membrane, and breaks up the rest chiefly into alcohol and carbonic acid, both of which substances are excreted again by the plant.

Alcohol and carbonic acid are not, however, the only products of the fermentation of sugar: there are produced simultaneously and invariably a certain proportion of glycerine and succinic acid, and probably also a variable proportion of some of the higher homologous alcohols, as propylic, butylic, amylic, &c. During the last few days of the fermentation, when the evolution of carbonic acid is copious, atmospheric air is no doubt almost entirely cut off from the *must* by the layer of carbonic acid gas constantly covering the surface. As soon, however, as fermentation becomes less energetic, atmospheric air has access to it, and various processes of oxydation are set up. Some of the alcohol formed becomes oxydized into acetic acid (vinegar); and most probably part of the albuminous and fatty substances of the *must* are converted into acids homologous with acetic acid, as propionic, butyric, propylic, pelargonic, &c., belonging to the series of so-called fatty acids. At the same time a variety of essential oils, termed ferment oils, are frequently produced, to which the perfect wine often owes part of its aroma.

As soon as a moderate quantity of alcohol has been formed in

the *must*, it effects great changes in the solubility of various constituents. Thus, bitartarate of potassium, being less soluble in alcoholic liquids than in water, begins to be deposited; and this precipitation keeping pace with the increasing amount of alcohol, the *must* becomes thereby less and less acid. On the other hand, the colouring matter of the skins, being soluble in spirit in the presence of acid, is gradually dissolved in proportion to the increasing amount of alcohol.

The progress of this first fermentation will, however, be greatly influenced by the temperature at which it takes place. If the temperature is low, fermentation proceeds slowly, and is accompanied by fewer products of oxydation; if, on the other hand, the temperature is high, fermentation goes on rapidly, and oxydation is at the same time augmented. Lastly, the quantity of sugar, as well as the amount of alcohol produced, exercises a considerable influence on the *must*. A *must* which contains more than 25 or 28 per cent. of sugar, does not ferment so readily as when it contains less; while if more than 12 per cent. of alcohol have been produced, fermentation is also to a considerable extent impeded. At low temperatures, indeed, it does not proceed at all; at a moderate temperature it proceeds but slowly—in which state of things great danger of excessive oxydation is incurred. On the Rhine, and in most parts of France, the temperature during the time of vintage is not generally very high, and is frequently but little above the lower limit at which vinous fermentation is possible, viz., 7° C. The *must*, also, in these countries rarely contains more than 25 per cent. of sugar. Their wines, therefore, may be allowed to ferment thoroughly without fear of excessive oxydation; whence they retain little or no sugar, and are almost free from albuminous substances. In Spain, Portugal, and other southern countries, however, the temperature during the vintage is high, sometimes almost reaching the higher limit, viz., 36° C., at which vinous fermentation is possible, and is within that which is favourable to acetous fermentation; the *must* also frequently contains more than 25 per cent. of sugar. In these countries, then, it is often impossible to allow fermenta-

tion to proceed to its full extent; and it is frequently necessary to check it altogether by the addition of spirit—thus bringing the alcoholic strength above the limit within which fermentation can take place. Such wines, therefore, retain part of the sugar unaltered, as well as of the albuminous compounds; moreover, sufficient time not having been allowed for that gradual and slow action of the atmospheric oxygen necessary for the production of the odoriferous principles, these wines when young are almost devoid of the *bouquet* that distinguishes the wines of more temperate climates.

Meanwhile the various substances thus produced have not been without chemical action on each other; the most important result of which is the production of a number of compound ethers by the mutual action of the various acids on the several alcohols present. To these compound ethers, together with the ferment oils previously mentioned, the wine owes in great measure its smell and bouquet. This first fermentation usually lasts from two to six weeks; after which the wine is left on the lees till the following spring, and is then drawn off into a fresh cask, in which a slight secondary fermentation continues, sometimes for years; the wine being repeatedly, during this time, drawn off from the sediment it deposits. During this secondary fermentation the removal of sugar is completed, the albumen is also either precipitated or oxydized, and a slight deposition of tartar continues; whilst more of the alcohol is converted into acetic acid, and, in red wines, much of the colouring matter and tannin is thrown down. The formation of compound ethers by the mutual action of the different acids and alcohols present goes on, and at the same time some of the compound ethers of the higher fatty acids at first formed are gradually decomposed and converted into ethers of the lower acids: as a consequence, the wine increases in bouquet. This formation of compound ethers, however, ceases long before all the acids present have been converted into ethers; the necessary conditions for such complete conversion being that the acids should be dissolved in absolute alcohol, and that the water produced during the formation of the ethers should be re-

moved. The presence of water prevents the complete etherefication of the acids, even when mixed with a large excess of alcohol; the greater the proportion of water, the less complete the etherefication. After the lapse of from three to six years, according to the nature of the wine and the temperature at which it is kept, this formation of compound ethers will arrive at a maximum, beyond which it cannot go except there be some alteration in the amount of alcohol or acid present, when the process will start again, so as to arrive once more at an equilibrium.

At the end of from five to twelve years, the wine may be considered to have arrived at maturity; that is to say, the slow chemical changes going on have reached the maximum amount that is still beneficial: after this the wine no longer improves by keeping, except to the taste of a few would-be connoisseurs. Generally speaking, the lighter classes of wines arrive sooner at maturity than the stronger and heavier. The foregoing sketch refers chiefly to pure, natural wines; in strongly fortified wines all chemical changes are more or less modified, and usually take a longer time for their consummation. Such wines require fifteen or more years to bring them to perfection; such time being, in great measure, necessary to undo and correct the evil done in brandying them originally.

The chemical changes taking place in the wine go on, however, unceasingly in cask, and even in bottle, owing chiefly to the oxygen finding its way through the sides of the cask, and even through the cork of the bottle; or from its having been absorbed by the wine in the act of transferring it from one cask to another, or in the bottling. Under the influence of this oxydizing action the wine gradually deteriorates, more and more alcohol is converted into acetic acid, colouring matter is precipitated, and the different odoriferous compounds, produced at first by the action of oxygen, are now gradually destroyed by it, and the wine perishes slowly but surely. Some wines pass through all these changes in a comparatively short time; others may keep for a hundred years or more.—*Abridged:* A. DUPRE *in Popular Science Review.*

SOCIAL DEVELOPMENT.

EVERY nation has had, or has, four stages to pass through, before attaining its highest social development. It shows itself either as savage, as nomad, as agriculturist, or as possessing a written language and coined money, and labour distributed amongst the various members of society.

1. The *savage* has few other than material wants, and these he endeavours to satisfy only for the moment. To appease hunger for the day; when requisite, to protect his body against heat or cold; to prepare his lair for the night; to follow the instinct of propagation, and instinctively to guard and tend his offspring—this constitutes all his care, all his enjoyment. He thinks and acts only for the day which is, not for the day which is coming. In this state man is necessarily a hunter and fisher, especially in zones where fruits and berries are scarce, or totally wanting during the greater part of the year. The savage has, therefore, no other alternative; he is compelled to fish and to hunt, or he must perish. In moments of necessity man has ample resources within himself; the savage finds everywhere materials for implements of fishing and the chase, and necessity teaches him how to fabricate and employ them. The earliest hunting implements of stone in every country are synchronous with the first appearance of the savage there, since he required at once the flesh of wild animals for food, their skin for clothing, and water for drinking. Even amongst the savages, also, we find traces of religion. Experience gradually awakens reflection; hunger is a troublesome guest, but is sure to call, when for a day or two the savage has not succeeded in killing any game. The prudent thought then suggests itself to him of saving a portion of the abundance of the day, and still more, that of carrying away the young calf or fawn, whose mother he has perhaps killed in the chase; and collecting several more of them, and forming at last a herd, he becomes—

2. A *herdsman* (nomad), subsisting chiefly on the produce of

his herds; the flesh of domestic animals his food, milk his beverage, skins his clothes. The chase and fishing, formerly his chief, now become his occasional occupations. There are various kinds of nomads; some of them have fixed habitations during all seasons, grazing their herds in the fields and in the neighbouring forests; others have fixed habitations only in the winter, migrating in summer with their tents from place to place; others, again, have no fixed habitations, roving about continually with their herds, living in movable huts or sheds on wheels, drawn by cattle, or in tents stretched on poles, and carried on the back of their cattle during their wanderings. When the grass-fodder begins to fail in one locality, the nomad breaks up his encampment, and drives his herds to others. There are no boundaries of possession; property is restricted to tents and herds. Distant excursions are undertaken, frequently also forays: the nomad is more ready to attack than to suffer himself to be attacked. Every family forms itself into a separate horde, in which the oldest member (the father of the family) is the chieftain or head: the government is patriarchal. Then come tradition and legend; the art of poesy springs into life: nomadic life is the element of poetry; the nomad is the youth of the human race. The first traces of science appear—leechcraft, botany, astronomy (?); but there is as yet no written language, no coined money—trade is nothing but barter.

At last he tires of his wandering life (or, rather, he is obliged to give it up, since the locality has become too small for the increasing population with its flocks); he builds sheds for his cattle, and lays up stores of fodder in barns; he burns a tract of forest-land, and sows corn in the ashes. His first field is a place where the trees are felled, a clearing in the forest, and his first plough a hoe. Thus the nomad gradually becomes—

3. An *agriculturist*, and takes a more stable social position. The movable tent gives place to a permanently fixed dwelling; the tilled corn-fields yield a richer harvest the more they are cultivated; the forests surrounding his home give him fuel and building materials; the fields provide him with grass and winter

fodder for his cattle; and even the waters yield him their tribute. The owner cultivates and guards his territory; he has devoted all his care and labour to it—it is his own; he will and he ought to possess it for himself and for his descendants. Other agriculturists settle in his neighbourhood; each builds his own dwelling-house, tills his own ground, and appropriates to himself the territory which he requires; territories are laid out, landmarks between properties are set up; the right of possession becomes more defined, and comprises also the landed territory. The patriarchal life ceases; every land-owner becomes a "man for himself." In order to mark his property, the owner of every fixed dwelling chooses his own private mark, his *bomärke*, which is the beginning of a written language. Thus, the first written letter (whether we suppose it to have been invented by the nomad or by the agriculturist) became a sign of right of possession; and probably the first written line was an agreement between neighbours relating to mine and thine, consequently a contract—the first step towards a future law in a more settled state of society.

A man's corn-field and pasture-ground, his forest, his mine, his lakes and rivers, supply most of his wants; not indeed all, but, on the other hand, some in superfluity. These superfluous things, then, can be exchanged by barter, and his other needs thereby be supplied; but his personal presence on his property is constantly required; the original trade by barter thus becomes inconvenient, perhaps impossible; some article which finds a demand everywhere, and which within a small compass contains a large value, is made the means of exchanging all kinds of commodities—in other words, it becomes money. At first it derives its value from its weight, but this arrangement has its attendant inconveniences; these are obviated when a piece of this article, of a fixed weight and standard, with its value stamped thereon, becomes coined money. With this and with the written language the agriculturist enters upon—

4. The fourth stage of civilization, in a still better organized state of society, where labour is divided amongst its various

members. Different professions (sometimes ranks so-called) arise. Some men occupy themselves in tilling the ground, working the mines, managing the flocks, &c.; others sell superfluities, and procure what is wanting by means of barter or trade with other communities and districts; others, again, defend the property of the community against foreign and domestic foes; and, lastly, others promote intelligence, education, and the cultivation of the mind; and a governor or chief is elected to watch over the whole, and to secure and guarantee the rights of all. Thus the nation is enabled, through the organization of society, to fulfil more and more completely its allotted mission—to attain the highest degree of culture and the highest stage of civilization.—*Abridged from* NILSSON'S *Primitive Inhabitants of Scandinavia.*